A

MANUAL

OF THE

PHYSIOLOGY OF MAN;

OR, A

CONCISE DESCRIPTION

OF THE

PHENOMENA OF HIS ORGANIZATION.

TRANSLATED FROM THE FRENCH

OF

PH. HUTIN.

Quicquid præcipies, esto brevis, ut cito, dicta
Percipiant animi dociles, teneant qne fideles.
HOR. *de Art. poet.*

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TRANSLATOR'S PREFACE.

It has, long ago, been tritely remarked—that there is no " royal road to Geometry;" this is equally true as regards the science of Physiology. There is no " royal road " in the pursuit of this knowledge; in studying the phenomena of Human Organization, we must be content to begin with the beginning; and hence, upon a subject which embraces nearly the whole circle of the Sciences, it can scarcely be expected, that a small volume, like the present, should contain all the requisite information. The work is offered merely as an outline, which, the inquiring student may at his leisure fill up; and it is hoped, that to the more advanced physiologist, it may not prove unacceptable—that, it may serve to refreshen faded recollections.

With these views, the Translator has been induced to present this Manual of Physiology, in an English garb: he has endeavoured as far as compatible with sense, to preserve the language of the author; and if, in some instances it may appear to be too closely followed, he must plead in apology, the desire of rendering the work,—a *faithful* translation.

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ERRATA.

Page 25, line 21, for *adiposous* read *adipose.*
Page 33, line 1, for *abuentes* read *abeuntes.*
Page 43, line 26, for *Dupuytzen* read *Dupuytren.*
Page 56, last line, *for* reputrefaction *read* resists putrefaction.
Page 58, for *defication* read *defecation.*
Page 72, and subsequently, *for* ramusculæ *read* ramusculi.
Page 77, and subsequently, for *bronchii* read *bronchi.*
Page 100, line 12, for *dastole* read *diastole.*
Page 167, last line but one, *read* taste *for* form.
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PREFACE

OF

THE AUTHOR.

All the Sciences, undoubtedly, command the most lively interest: but, that which has in view, Man—his organization, and the phenomena connected therewith, must present something still more interesting. Indeed, can there possibly exist, for a rational being, a more important study than that of himself, by scrutinizing and unveiling the mechanism of his own organization,—the wonders and the secrets of his life? Physiology, then, in this respect, is every man's science. In the study of it we are struck with a multiplicity of gratifying revelations—therein the philosopher finds the grounds of a sound doctrine. Is it not sufficiently known how much Bossuet insisted on the necessity of blending, as it were, physiology with morals? In a

word, from this study, the physician borrows the principles of his science, without which he would be liable at every step to fall into the most disgraceful and the most dangerous empiricism.

On this important subject we have numerous writings and Treatises *exprofesso;* and only to speak of those which do honour to the age, we may particularly mention the valuable works of Richerand, Dumas, Chaussier, Magendie, Adelon, &c. In laying before the pupils the substance of these eminent masters, in a simple, clear, and concise manner, (far be from me, the foolish pretension of presenting them with a work perfect and complete,) I have had nothing more in view than to remove the difficulties which might obstruct their first steps in the career, to abridge their labours, and promote the progress of their minds; that they might, at some future day, pay to their body, and to society at large, that tribute of utility expected from each of its members.

The order I have followed in this Manual is nearly the same as that, which has been adopted by the faculty of medicine of Paris. I first lay down a few general considerations as a natural introduction to the study of man; next, I examine, individually, as well as generally, the different parts which constitute human organization; and, finally, I am thus led to the history

of functions, or of the divers phenomena observable in man during the course of his life.

In the individual study of each function, I describe, as concisely as possible, the general disposition and the structure of the organ commissioned to perform it: I then study the function in itself: Finally, after having described the mechanism and result of that function, I lay down the principal theories or hypotheses by which physiologists are divided. When I chance to combat their opinions, I ground myself much less upon my own means than upon those scientific men who have appeared to me to come nearer the truth and the secrets of human life.

MANUAL

OF THE

PHYSIOLOGY OF MAN.

GENERAL Physiology is a natural science, that treats of the phenomena peculiar to organized bodies; but as these bodies are innumerable, and moreover as they form two distinct kingdoms, Physiology is first divided into *vegetable* and *animal*, according as vegetables or animals come under consideration. Finally, if life is studied in one single species only of these two living kingdoms, physiology is called *special*—such is, particularly that of Man, of which we are about to treat.

INTRODUCTION.

General Consideration of the Bodies of Nature.

THE bodies or beings, whose existence has been called in question by a few metaphysicians, manifest their presence by a certain number of properties, which

create in us a series of determined sensations. The immense science that embraces them, constitutes what is called natural philosophy.

Considering, in a general view, and in a philosophical manner, the admirable variety of beings which constitute the universe, we are struck with amazement on seeing that they may all be reduced to a certain number of elements, which, according to the present state of the sciences, are fifty-six in number, four of which are imponderable; but these elements or material parts of bodies, united in divers numbers and proportions, are linked in their combinations by two distinct powers: the one the force of chemical attraction; the other the force of organic attraction, that impress on them two particular modes of existence, which shall for a few moments claim our attention.

All the bodies which share in common the empire of nature, are inorganic or organic: Every thing is different between these two classes of beings, not only their material composition and their force of aggregation, but also the divers parts they perform in the universe. A slight glance will suffice to establish between them, a *priori*, a decisive, and distinct character. It is life, properly so called, which is only met with in beings whose peculiar structure assumes the name of *organization*, whilst inorganic bodies have only a passive existence depending on chemical affinity and on the laws of physics. Let us take a summary view of the

material differences existing between these two modes of being:—

1. *Composition.*—Inorganic matters are composed of homogeneous particles, united by an universal force—attraction, the ordinary conditions of which are sufficiently known, so that the chemist may decompose or reproduce them at will. Some of these particles are elementary or indecomposible, and present, generally speaking, a geometrical form. The others are the result of the divers combinations of the former, and are called integral:—aggregated in various quantities, and in an order more or less irregular, these particles constitute inert bodies, exceedingly variable, both in volume and form.

Organized bodies, on the contrary, are composed of heterogeneous parts: of solids, which constitute the organs, and fluid parts, which are contained within the solids. These divers dissimilar parts are united by a particular force—*vital affinity*, the laws of which are completely unknown; so that it is impossible to decompose and recompose a vegetable or an animal. We distinguish in these beings chemical and organic elements, from the re-union of which, bodies of different volume and form, originate.

2. *Origin.*—Inorganic bodies are sometimes irregularly formed, by a combination of the divers elements; at other times they are separated from a mass,

or again they are deposited by the waters that held them in suspension.

Organized bodies, on the contrary, invariably originate from bodies similar to themselves, their reproduction is effected by actual generation. Some modern authors, however, still admit, with the ancients, of a spontaneous generation in the two organized kingdoms.

3. *Growth.*—Inorganic beings may at every moment considerably increase or diminish in volume. These phenomena, which are independent of the bodies themselves, are invariably the effects of the general forces of matter.

Organized bodies, on the contrary, incessantly assimilate to themselves parts of matters with which they are surrounded, outwardly expelling at the same time the materials by which they were previously formed. This increase by intus-susception constitutes nutrition properly called.

4. *End.* Mineral substances do not of necessity end: their destruction is brought on by external bodies, whose affinities are superior to those which gave them birth. The dissolution of their elements can never be spontaneous.

Organized beings, on the contrary, have a determined end: *Death*, the name given to it, occurs with a total cessation of nutritive functions. The body then returns to the class of inorganic beings.

Mineralogy, chemistry, and physics, have inorganic bodies in view, whilst the study of organization, and he phenomena of organized bodies, exclusively belong to general anatomy and physiology; the numerous bodies that form the subject of these two last sciences are divided into vegetables or inanimated beings, and animals or animated beings. The general characters we have pointed out, in speaking of organized bodies, equally belong to both; but there exists between them some particular features, which justify the division of these two beings into two distinct classes.

DIFFERENCES BETWEEN VEGETABLES AND ANIMALS.

1. *Composition.*—In both classes we meet with organization, but, generally speaking, it is more simple in vegetable than in animals; with the former the solid parts predominate, whilst fluids form the more considerable portion in the latter. In the former again, there appears to exist but one single organic element—the *cellular*; whilst three, at least, are detected in the latter, —the *cellular*, the *muscular*, and the *nervous*.* Finally, the chemical composition in general also differs:

* However, Waller, Linnæus, and Brachet, considered the central marrow in vegetables, as analogous to the nervous system of animals; and, in recent researches, M. Dutrochet affirms, not only to have met with nervous ganglia in several plants, but moreover with muscular fibre.

Oxygen, hydrogen, and carbon, are the chemical elements of vegetables. In addition to these, a considerable proportion of azote is observable in animals.

2. *Nutrition.*—Beings, in the two organized kingdoms, gather from around them materials which they elaborate and assimilate to themselves; but the nutrition of vegetables is effected by inorganized matter; animals, on the contrary, almost exclusively feed upon organic substances. The nutrition of a vegetable takes place throughout its surface, whilst in animals, the alimentary substance undergoes, in a particular organ, the *digestive tube*, a special elaboration—*digestion*, which prepares it for assimilation. In truth, with respect to vegetables, we might say that digestion takes place in the earth, which, according to Hippocrates, is the stomach of plants, *quemadmodum terra arboribus ita animalibus ventriculus.*

Finally: Nature has endowed the animal, and the animal only, with the faculty of effecting nutrition at will, whilst the vegetable receives it passively.

3. *Sensibility.*—Some plants enjoy the property of receiving impressions and of reacting; but none enjoy sensibility, properly so called, that is to say, the faculty in virtue of which, a being is conscious of itself, sensible of its existence, perceptible of pleasure and pain; their existence consequently flows on irresistibly, without perception or will.

The animal, on the contrary, that enjoys this fa-

culty, is conscious of its existence, perceives and executes at will, certain acts of life, and experiences sensation, pain, and pleasure.

4. *Locomotion.*—That faculty, by which the body moves in part or altogether, in consequence of a determination of the will, exclusively belongs to animals; whilst vegetables, fixed to the soil, originate, grow, and die, in the very same spot. It is incorrect in some authors to say, that certain bulbous plants partake of this faculty, in common with animals. If we observe them for several years, we actually find they are displaced; but let it be remembered, that it is no longer the same plant: it is a new bulb, that grows along the former, which died away with the plant it had produced.

With these two faculties, proper to animals, arises a third, equally peculiar to them—it is *language*.

5. *Generation.*—In animals, re-production takes place by the voluntary re-union of two individuals of different sexes, whilst the greater number of plants are hermaphrodites; that is to say, the same flower contains the two sexes. But there exists another mode of re-production, which, in the two species of organized beings, bears the utmost resemblance: it is simple, and takes place without the concurrence of two sexes. The confervi, the polypi, for instance, cover themselves with gems, or buds, similar to a number of plants, which, by separating from the parent, give birth to new indivi-

duals, similar to those by which they have been produced.

From the comparative sketch we have just drawn of animals with vegetables, we have been able to remark, that these beings differed from each other in some degrees of complication or of simplicity only. And if we reflect that to be able to trace distinct features, we have been compelled to resort to the most elevated amongst them, it will be easy to foresee, that in descending the animal scale, nature will present numerous exceptions, which will incessantly oppose a division to which she seems to yield with reluctance. In fact, there are animals in which the organs of sensibility and of locomotion have never been discovered; whilst, on the other hand, the existence of these instruments, (functions consequently) seems, by recent researches, to have been placed, with respect to certain plants, beyond a doubt.

OF ANIMALS IN GENERAL.

In consequence of the information we have just acquired, we may define animals as living, organized bodies, sensible, consequently receiving various sensations from the divers surrounding objects, and most part of them enjoying an independent and free existence.

Animals in general present a symmetrical form, and

may be divided by a vertieal line into two lateral halves; they are provided with a nervous system, extended on the one part to all the regions, and leading on the other to central masses; they are possessed of organs for special sensations, to establish their connection with the universe; they are covered with an external membrane, *the skin*, which, being reflected, and continued internally, forms a cavity, intended for the reception of food. From this cavity, generally, numerous vessels branch off, commissioned to absorb the alimentary juiee, and to distribute it to all parts of the body; finally, most animals are endowed with respiratory organs, in which this matter is submitted to the action of air; with secretory organs, wherein a part of this nutritive juice is eliminated from the mass, with muscles for motions; finally, with genital organs, intended for the reproduction of the species.

Such are the general characters of animal organization: But from the most humble of animals up to those situated at the summit of the scale, at the head of which is man, it admits of such innumerable modifications, that I consider it indispensable to prepare ourselves for the study of the latter, by taking a general view of the organization and the functions of the different classes of the animated kingdom, so as to enable us to follow nature from the most simple to the most complicated of her works.

1. *Nutrition.*—In the inferior animals, the *amorphi*,

for instance, the mass, is homogeneous, spongious; no particular organ can possibly be detected; the absorption of nutritive substance is effected throughout the surface of the body. Further on, in the *radiated*, the rudiments of a digestive canal are observable; we find a cavity, either simple, or with continuations, extended to all the parts of the animal: in this instance nutritive absorption takes place from the two surfaces. Finally, this cavity soon crosses the body, the aliment is admitted into it by an orifice called the *mouth*, and its residue expelled by another called the *anus*.

First, the nutritive juice is immediately conveyed by imbibition to all parts of the body, without the intermedium of vessels: such is the case in the *radiated* and in *insects*. In the more elevated classes, the fluid absorbed in the intestinal canal circulates through vessels divided into arteries and veins, at the re-union of which we often meet with a heart either simple or double. In the vertebrated, there exist moreover lymphatic and chyliform vessels.

With the greater part of animals the nutritive fluid requires the contact of air, in order to be rendered fit for nutrition: for this purpose Nature has provided the subjects with *respiration*. The *radiated*, and some of the *articulated*, are denied the organs peculiar to this function: respiration then is called *general*. In every other animal, on the contrary, this function is *localized*; and, accordingly as it is effected in water, or in atmos-

pheric air, the organs are modified, and assume the denomination of *gills*, or *lungs*.

The nutritive fluid is, in the very same manner, assimilated to the organs throughout every class of the animal kingdom. It renews their substance, and keeps up their temperature.

In the different species of animals, the movement of decomposition is as variable as that of composition. The nutritive fluid incessantly eliminates from its own mass a certain proportion of its parts. This is what constitutes *secrètion*,— the products of which differ accordingly as they are immediately and outwardly expelled, or again as they return to the nutritive element. In the infusoria, the polypi, the acalephæ, the echinodermata, and in the intestinal worms, this function is reduced to a simple exhalation, effected throughout the surface of the body. In certain *arachnida*, in the *crustacea*, and in the *mollusca*, we begin to find a liver and salivary glands; the vertebrated, are moreover, possessed with kidneys, a pancreas, &c.

2. *Sensibility.*—Every animal appears to be possessed of this faculty; but they do not all enjoy it in the same degree. The nervous system is the instrument of this function. The *infusoria* and *polypi* seem to be deprived of it. Its rudiments begin to appear in the most part of the other *radiated*. Around their mouths we perceive small ganglia communicating to-

gether by threads, which are moreover distributed to the two surfaces of the body; in these classes we do not yet discover a central ganglion: impressions are immediately followed by motions.

That central mass, called *brain*, begins to display itself in the *articulated;* situated above the œsophagus, it projects all along the digestive canal two threads, which re-unite together on a level with each articulation, and are extended to all the parts. The *molusca* present nearly the same disposition; in the *cephalopoda* only, the brain is contained within a kind of cartilaginous cranium.

In these two classes, the nervous system is already modified in such a manner as to give birth to organs for special sensations; some are provided with tentacula, proper to touch, the most part perceive odours. With them, however, this faculty, as well as that of perceiving sounds, appears to arise from a tactile impression, since we cannot as yet discover in them any organ for these senses. The *gasteropoda* present small black spots, which are considered to be the rudiments of the instrument of vision. The *insects*, the *arachnida*, the *crustacea*, the *mollusca*, *cephalopoda*, &c. are provided with simple or compound eyes, frequently pediculated. In the two classes of animals, the complexity of the nervous system is gradually seen to increase. Here we evidently find, what is

not observable in the preceding, nervous centralization; hence the liberty of motions; the organs of sense; hence again special sensations; and, finally, from these two faculties there arises a third, which, without previous education, tends to the preservation of the individual and of the species—and this is *instinct*.

Finally: In *vertebrated* animals, the nervous threads just alluded to, are no longer indistinctly extended to the vegetative and animal functions. The nervous system assumes a particular character; we find it invariably composed of two principal parts:—1st. Of the reunion of numerous ganglia analogous to those we have already met with in the inferior classes, and which hold under their dependence the organs of nutrition, and the principal ones of reproduction; and this is called the *grand sympathetic*. 2dly. Moreover, there exists another nervous mass, which is continuous with the preceding, and consisting, 1st. of a long cord contained within the vertebral canal—*spinal marrow*, sending off all the nerves by which the muscles intended for voluntary locomotion are animated: 2dly, of a mass more or less voluminous, generally contained within an osseous cavity called cranium, it is the *encephalus*, to which the organs of the senses tend, and which presides over the moral faculties. This organ, the nearer we rise towards man, holds more and more under its dependence the whole of the nervous apparatus—we may even say life.

Thus, in the class of vertebrated animals, besides irritability, general sensibility, voluntary motions, and instinct, we meet moreover with cerebral acts, which gradually rise up to intelligence.

3dly. *Locomotion.*—That faculty which animated beings are possessed of, of performing partial and general motions, gradually increases in the series of animals. In those which constitute the inferior classes, we can discover no organ peculiar to this function; however, the *infusoria*, for instance, move with astonishing rapidity: the very same thing with the *rotiferi* and the *polypi*, which are also denied muscular organs. These organs begin to make their appearance in the *acalephæ* and the *echinodermata*. Further on, the apparatus of this function becomes the more and more developed, hard parts are annexed to it, which form the framework of the body and the levers of the limbs. In *insects*, the hard parts are external, and form a part of the envelope; they are composed of parts articulated: the muscular fibres are situated interiorly, and give motions to them. In the immense class of *vertebrated* animals, on the contrary, the hard parts are internal, and form particular organs (*the bones*), to which the muscles are inserted.

4thly. *Expressions.*—That faculty which animated beings have of communicating their sensations, essentially differs in animals; it is unobservable in such as are denied sensation and volition. In a higher

class it unfolds itself, but at first the expression is barely perceptible. Here we can only discover the passions which agitate the animal, by the divers changes which take place on its surface, and which constitute *gestures*. Finally, the superior classes are endowed with a particular instrument, the *larynx*; situated in the course of the respiratory tubes, it is productive of a mode of expression which consists in *sounds*: the *voice* and *speech* are modifications of it, peculiar to man.

5thly. *Generation.*—In the inferior classes we find no particular organs for reproduction. In such instances as in the *infusoria*, the body admits of being divided into several fragments, which form as many new individuals (*fissiparous generation*). Or, again, gems shoot from the surface of the animal, and by falling off produce a new being—such are the polypi (*external gemmiparous generation*). Or finally, again, as is observable in the *acalephæ*, it is internally that the ovariform gennus are developed, and this constitutes *internal gemmiparous generation*. In more elevated classes the concourse of organs of different sexes is indispensable for reproduction. Most commonly these organs belong to different individuals. We know of no other hermaphrodites than the annelides, and even here reciprocal copulation takes place.

Classification of Animals.

Linnæus, regarding the circulatory apparatus, divides the animated kingdom into two grand classes: *animals provided with red blood, and those only possessed of white blood.*—Next, he subdivides the first class into four orders: *quadrupeds, birds, reptiles,* and *fishes;* the second class includes *insects* and *worms.*

Lamark, from a striking feature in the apparatus of locomotion, gives to these two classes the names of *vertebrated* and *invertebrated.* Cuvier, at first, had admitted of this classification. He subdivided the first class into four orders, after the manner of Linnæus, but he reckoned five in the second class: the *mollusca, crustacea, vermes, insecta,* and *zoophyta.* Since that, this eminent physiologist, taking into consideration the animal functions, has divided animals into four classes: the *radiata,* the *mollusca,* the *articulata,* and the *vertebrata.* Finally, De Clainville, grounding himself on the character of organization, gave a classification, a sketch of which is annexed.*

Now, that we have drawn a parallel between inorganic, and organic bodies, between vegetables and animals, and that we have risen from the most humble of the beings, up to man, we have obtained a sufficient degree of knowledge to begin the particular study of the latter.

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* See the annexed table.

A TABLE OF THE ANIMAL KINGDOM.

1st. AMORPHOZOAIRES.—Homogeneous organization, no trace of a digestive, nervous, or muscular apparatus.

2dly. ACTIOZOAIRES, or *radiated.* — Radiated form, digestive cavity with one or two openings, nervous system null or consisting of ganglia situated on a level with each ray of the animal: these ganglia are provided with a common centre, they are indistinctly distributed to the two surfaces, the rudiments of a muscular apparatus unexisting; generation fissiparous or gemmiparous.

3dly. ARTIOZOAIRES. *Symmetrical Form,* Includes the

- MALACOZOAIRES, or *Mollusca.* — Body soft, in one mass, no articulation; digestive canal perfect, chyliferous vessels, pulmonary or bronchial respiration; double fleshy ventricle, that receives the blood from the organs of respiration, and propel it to all parts of the body; secretory organs, liver, salivary glands; generation by the concourse of sexes, in some species hermophrodism; there is a brain or nervous centre, and a spinal marrow, situated along the digestive canal; some are provided with eyes, some apparently enjoy the five senses.
- ENTOMOZOAIRES, or *articulated,* subdivided into
  - ANASTEOZOAIRES, externally articulated, or *invertebrated.* — Trunk, generally supported by four legs; intestinal canal complete; trachea respiration disseminated; no circulation, properly so called; devoid of muscles, the apparatus of locomotion presents hard parts, but they are external and belong to the skin; spinal marrow under the digestive canal: in some respects these animals are inferior to the mollusca.
  - OSTEOZOAIRES, internally articulated, or *vertebrated.* — Differing from the preceding by the animal functions, their body consists of a trunk divided into two or three splanchnic cavities; nearly all are provided with limbs; a series of bones form a long shaft, occupying the median line of the body, which contains the spinal marrow; at its extremity is the head, composed of a cranium containing the brain, and of the face, which presents the mouth and the organs of the senses; the mouth consists of two horizontal jaws, provided with teeth, or with a horny substance; the intestinal canal is furnished with secretory glands, generally consisting of the salivary glands, the liver, the pancreas. All are endowed with a double circulation, a heart, arteries, veins, lymphatic and chyliferous vessels, lungs, except fishes (which have gills:) the sexes are distinct, all vertebrated animals have bones articulated together, which constitute the frame-work, muscles which are inserted to the bones by the means of tendons, and give them motion; all these animals, in short, are provided with red blood; and, amongst their secretions, the most part present urinary depuration.

According as the fœtus has, or has not, completed its development when it is expelled or brought into the world, contained or not within its envelopes, we subdivide vertebrated animals into:

Oviparous.—The germ is contained within its envelopes with sufficient nutritive matter till its expulsion: birds, reptiles, and fishes, are included in this order. Certain reptiles, and a few fishes, retain their eggs internally to the moment of expulsion: these are the *ovo-viparous.*

Viviparous.—The ovulum, fixed in the uterus, receives its nourishment through the placenta, which forms the communication with the mother; it is expelled as soon as it has attained its full development. Their animal functions are more perfect, their instinct greater: the family are provided with a particular organ (the breast) intended to prepare the first food for the new being. It is to this group that man belongs, who, by his intellectual faculties, occupies the summit of the scale.

OF MAN.

Without apparently having had Man in view, we have already pointed out many features that belong to him; but, as a natural consequence of the elevated station in which he ranks amongst animals, we must expect to find in him—independent of the general characters he possesses in common with the latter—an admirable degree of perfection, both in his organization and in his faculties.

Anthropology, or the science of man, includes the study of his structure, and that of his phenomena.

Organization of Man.

The exterior conformation of the human body is symmetrical; the point of reunion of the two lateral halves is pointed out by a median vertical line, called *raphe*. This symmetry is particularly remarkable in the organs of animal functions, it is not, however, perfect in these organs; and much less so in those of generation; finally, it is not to be detected in those organs connected with nutritive functions.

The structure of man constitutes an organization, consequently, as in all organized beings, we observe in him solids which compose the organs, and fluids that are circulated in them.

Of Solids or Organs.

We term organic solids, all such parts of the body that give it form and impart motion to it; the particles of which are sufficiently adherent not to be fluid, and to resist the laws of gravity.

Anatomists are divided with respect to the number of solids. Chaussier refers them to the twelve following:—

Bones are evidently the hardest solid: they form the frame-work of the body, and the lever of the limbs.

Cartilage is, next to bone, the most compact substance: it is intended to increase the articulatory extremeties of bones, and to extend them.

Ligaments are organs not easily lacerated, calculated for purposes of resistances: some belong to the bones, others to muscles.

Muscles: Red, contractile organs, intended for motion, forming the principal mass of the body.

Vessels: Canals through which fluids are circulated.

Nerves are organs of a soft, pulpy nature—they are the agents of sensibility.

Ganglia: Globular organs, stationed in the course of vessels and nerves, formed by the interlacing of both, and destined to cause the fluids, circulated in these organs to undergo modifications.

Follicules: Organs, generally small, intended to separate from the blood a humour proper to lubricate every membranous surface submitted to contact.

Glands: These are also secretory organs, but of a more complicated nature, and invariably provided with a district excretory duct.

Membranes: A kind of sheet, intended to form, sustain, and line the divers organs. Bichat divided them into simple and compound, according as they were formed of one or more layers.

Cellular Tissue: A sort of spongious substance, serving to connect, and at the same time to separate the organs, whose parenchyma it forms.

Finally, *The Viscera:* The most complex solids in the human body, situated in the splanchnic cavity, intended for the support and propagation of life.

In this classification of solids, which is generally admitted, we might, I think, have begun with the teeth, which Chaussier has allowed to pass unnoticed.

The state of inorganic solids is owing to the equilibrium established between the expansive form of caloric, that tends to separate the particles, and affinity, which tends to their cohesion. Is this the case with organic solids? The greater number of physiologists refer the solidity of the latter to an unknown power—to LIFE. One thing, however, is certain, that these solids only decompose after death, although their state may be more or less altered by disease.

The ancients had reduced the organization of solids to one elementary fibre, which they considered as composed of earthy matter and gluten; they di-

vided it into linear and lamellated; and, in their opinion, from this fibre originated the cellular tissue, which subsequently gave birth to all other organs, divided by them into similar and dissimilar.

First, it is evident, that this microscopical fibre is nothing more than a creation of the mind; besides, the cellular tissue, as we shall soon see, is not the sole elementary tissue of our organs.

Modern anatomists acknowledge three elementary tissues: the *cellular*, the *muscular*, and the *nervous*.

The *cellular* tissue is the most generally distributed. It is the only one met with in the inferior classes; in the more elevated, it forms the parenchyma of every organ. It is this which condensates into skin at both surfaces; it is this which, hollowed canal-like, gives birth to vessels, &c.—and is essentially formed of concreted gelatin.

Muscular Tissue.—This tissue is more sparingly extended; it is composed of contractile globules, which, according to De Clainville, are formed in the cellular tissue.

Finally, the *nervous* and *madullary* tissue, less prevalent than the preceding. It is composed of globules, which, according to the same author, are developed in the muscular fibre.

To these three elementary tissues, Chaussier adds a fourth, named by him albugineous fibre. But it is generally considered as condensated cellular tissue

These tissues, in their simple shape, by interlacing and being modified in different manners, give birth to every organ in the human body; and these organs, being grouped, for the performance of a function, constitute apparatus.

Bichat also rejects the elementary fibre of the ancients, and refers the composition of every organ to twenty-one tissues, seven of which he calls generating: the exhalant, the absorbent, the cellular, the arterial, the venous, the nervous organic, and the nervous animal. The fourteen others are formed by these, but associated together in different numbers and proportions, and incrustated with special substances. Bichat, for this very reason, calls them *compound* tissues; they are, the osseous, medullary, cartilaginous fibrous, fibro-cartilaginous, muscular animal, muscular, organic, nervous, serous, synovial, glandular, dermoïd, epidermoïd, and pylorous systems.

Beclard has modified the doctrine of Bichat, and has referred the organic solids of the human body to the eleven following tissues: the *cellular*, the *adiposous*, the *serous*, the *tegumentary*, the *vascular*, the *glandular*, the *ligamentous*, the *cartilaginous*, the *osseous*, the *muscular*, and the *nervous*.

All these tissues are not, as some anatomists have supposed, the mere creations of imagination; they essentially differ from each other, with respect to their physical properties, and their organization; and let

the part of the body, wherein they are examined, by what it may, the part they act is every where the same, distinct in every one of them. The same may be said with respect to their diseases; Pinel and Carmichael Smyth, for instance, have remarked, that the inflammation of a single tissue, presented the same features in every organ.

Of Fluids or Humours.

This name has been given to all the parts of the body, whose particles have such slight cohesion, that they can easily move over each other, and be separated by their own specific gravity.

Caloric and water are the principal agents of fluidity; but there exists, moreover, a particular force depending upon life, which prevents the decomposition of these humours, as is proved by the alterations they quickly undergo, when they no longer form a part of the animal.

In consequence of deficiency of adhesion between their particles, liquids assume a fluid or gazeous state; and, in consequence also of their composition, they are simple: or again, if they contain any bodies, in solution, they are called compound.

The ancients reduced all the humours of the body to four, namely: the *blood*, *phlegm*, *bile*, and *atrabile*; to each of these four humours answered, according to their opinion, one of the four ages, one of the four temperaments, and one of the four seasons.

Subsequently, humours were divided, according to their physical and chemical properties, into *acids*, *alkalines*, and *neutral;* into *saline*, *oily*, *soapy*, *mucous*, *albuminious*, *fibrinous*, &c.

Latterly, they have been classified with respect to their uses, into *alimentary* and *excremential*. This classification has been adopted by Bichat. Richerand is of opinion that all humours are *excrement—recrementitial.* Chaussier divides them into five classes: chyme, chyle, blood, and the secreted humours.

It would be correct to divide humours in the manner of Beclard and Adelon, into three principal genera, namely:—

1. *Humours of Absorption.*—They are composed of nutritive fluids, outwardly taken: *chyle*, *oxygen of air;* 2, of all other materials proceeding from internal absorption, *lymph*, and of a few other principles we are not perfectly acquainted with, and proceeding from venous absorption; all these fluids unite to form the blood.

2. *Humour immediately Nutritive*, or *arterial Blood*, is the result of the re-union of the proceeding fluids, modified in a remarkable manner by one of them—*oxygen*, in the act of respiration.

3. *Secreted humours* proceed from the blood, and are remarkably numerous, with reference to the form and organization of the organ that produces them. They may be subdivided: 1st, Into humours of *perspi-*

ration, such are cutaneous and pulmonary *perspirations;* the synovial serous humours, and adipose substances; all the humours of the eye, the lymph of Cotugnius, the water of the amnion, that of the umbilical vesicle, &c. 2dly, *Into follicular* humours, *cerumen*; the humour of *meibomius,* and the different mucous fluids. 3dly, The *glandulous* formed in glands, provided with excretory ducts; such are the *lachrymal salivary* and *pancreatic humours—bile, urine, semen,* and *milk.*

Such are, in general, the humours we meet with in the human economy. We shall return to each, in treating of the functions, to which they individually belong.

In man, as well as in any other animal, the solid and fluid parts are incessantly converted from the one into the other; thus their composition is the same: the immediate principles of which are, fibrine, gelatine, albumine, mucous, oil, water, sugar, osmazoine, resin, urea, picrocholine, zoohermatine, phosphate, and carbonate of lime, acetic, lactic, and oxalic acids, &c. These matters are themselves a compound of a certain number of elements, which are oxygen, hydrogen, carbon, azote, phosphorus, sulphur, chlorate, iron, manganezium, calcium, potassium, sodium, silicium, magnesium, aluminum, and of the imponderable fluids, caloric and electricity, &c.

In the human organization the proportion of fluids by far exceeds that of solids, but it is next to an impossibility to ascertain them correctly. They vary,

according to ages, sexes, and to individuals, &c. Richerand affirms that fluids are to solids as six to one; Chaussier says they are as nine to one.

Of Vital Force, or Principle.

By this word is understood the whole of the powers and laws by which animal organization is animated and regulated. Struck with the immense differences observable in all the bodies of nature, the ancient philosophers admitted, in organised bodies, of a principle of special actions. This idea, reproduced under the denomination of vital force, has undergone in modern times divers modifications, which it will be proper to notice. Physiologists have made this principle the subject of violent disputes; and by dint of reasoning, some even have gone so far as to grant this metaphoric being, actual existence. Some have mistaken it for the rational soul, others have considered it as a faculty of matter; finally, some have viewed it as a result of organization.

Human organization presents during life a numerous series of different phenomena, which may be divided into three different orders. Some are evidently of a chemical nature, others are the result of physical and mechanical laws; finally come the vital phenomena. The latter incessantly modify the former, their cause is that very principle now under consideration; it is this principle that protects us against the universal forces to

which every inorganic body is subject. It is to this class that intellectual and moral phenomena belong.

This force comprehends several distinct qualities. 1st. One denominated *vital affinity* or *force of formation*—it is this which presides over generation, nutrition, and cohesion of the parts. 2dly. *Irritability*: It consists in impressions immediately followed by motions more or less appreciable, whence are derived the varieties called tonicity, vascular contractility, and muscularity. 3dly, Finally, *Sensibility*, or nervous force, which includes all received impressions, special sensations, and latent sensibility, not admitted by a number of physiologists. There exists another faculty peculiar to man of an elevated order—I allude to intellectual and moral acts.

Many of the modern physiologists refer all the vital properties to a single one—*sensibility.*

Of Organism, or Phenomena of Organization.

Now that we have formed a correct idea of human organization, and of the forces by which it is regulated and animated, we arrive at the study of his phenomena, or of *organism,* to use the judicious expression of *Stahl*.

Already, the actions of man are partly known to us, we have successively presented them in our general considerations on the animated kingdom, and as nearly as possible in the very order of their development. In fact, for the same reason that man is an organised

being, we are already conscious that his actions constitute life; so also, as man is an animal, we are aware that he enjoys the faculty of feeling, of moving, of expressing his passions, and of being the arbitrator of his life. Finally, by this reason, that man is binary, vertebrated, and biman, the mechanism of his functions is the most complex possible; he is endowed with peculiar faculties, with intelligence, speech, &c. &c,

All the organic actions unite to form a certain number of functions, amongst which there exists, according to their importance, a very remarkable subordination; and besides this dependance in the functions, there moreover exists between them such intimate connexions, that they appear to be reciprocally linked, and to admit of no other influence than that of intelligence. Functions have certain general characters, and also peculiar features, which render them distinct: First, they each are possessed in the animal economy of an apparatus of organs; subsequently, each acts a different part, but all tend to a common end, which is the preservation of man, both as an individual and as a species: they are, as *Richerand* terms them—*his means of existence*. From the harmony of the whole, life results—their study is the object which physiology has in view.

Number of Functions.

Physiologists are divided with respect to the number of functions in man. *Vicq-Dazir*, and *Fourcroy*, admit of nine: *Digestion, circulation, respiration, nutrition, secretion, ossification, irritability, sensibility,* and *generation.* *Cuvier* also admits of nine, but different from the preceding: *Sensations, motions, digestion, absorption, circulation, respiration, perspiration, excretion,* and *generation. Bichat* reckoned thirteen: *Digestion, absorption, respiration, circulation, nutrition, secretions, external senses, internal senses, motions, voice and speech, exhalation,* and *calorification.* Richerand mentions ten, namely, *Digestion, absorption, respiration, circulation, nutrition, secretion, sensation, motion, voice, speech, generation.* And, finally, Chaussier admits of twelve, which are: *Respiration, circulation, innervation, digestion, absorption, nutrition, secretion,* the *external* and *internal senses, locomotion, voice,* and *generation.*

Classification of Functions.

Authors no more agree with respect to the order in which it would be proper to classify functions, than with respect to their number. Each physiologist has either created or modified a classification, so that we possess a great number. The functions, whose actions are simultaneons, or necessitated, are so extensively

TABLE

OF THE ORDER ESTABLISHED IN THE STUDY OF THE FUNCTIONS.

- **FIRST CLASS.** FUNCTIONS WHICH SERVE FOR THE LIFE OF THE INDIVIDUAL.
  - **FIRST ORDER.** By assimilating to his substance the aliment on which he feeds. *Functions of Nutrition.*
    - 1st Genus—*Digestion.*—Extracts the nutritive part.
      - Prehension of food
      - mastication and insalivation
      - deglutition
      - chymification
      - chylification
      - defecation
      - accidental excretions.
    - 2d Genus—*Absorption*:—conveys it to the circulation.
      - chylous
      - lymphatic and venous.
    - 3d Genus—*Respiration*:—combines it with the oxygen of air.
      - inspiration
      - expiration
      - sanguification
      - alteration of air
      - alteration of blood.
    - 4th Genus—*Circulation*:—distributes it to all the organs.
      - action of the heart
      - action of the arteries
      - action of the capillary vessels.
      - action of the veins.
    - 5th Genus—*Assimilation*:—assimilates it to their own substance to repair losses.
      - composition
      - decomposition.
    - 6th Genus—*Calorification*:—keeps up the heat of the body to a permanent degree.
      - influence of the lungs and of the nervous centres.
      - of heat
      - of cold.
    - 7th Genus—*Secretions*:—incessantly eliminate a part of the mass of the blood.
      - Exhalation
        - serous
        - cutaneous
        - adipose
      - follicular secretions
        - sebaceous
        - mucous
      - glandular secretions
        - tears
        - saliva
        - pancreatic juice
        - bile
        - urine.
    - 8th Genus—*Innervation*:—gives life to all the preceding functions.
      - influence of innervation over organic functions.
  - **SECOND ORDER.** By establishing his connection with surrounding beings. *Functions of Relation.*
    - 1st Genus—*Sensations*:—warn us of existence.
      - touch
      - taste
      - smell
      - sight
      - hearing
      - internal sensations
      - morbid sensations.
    - 2d Genus—*Intellectual faculties*:—they perceive, judge, and reason of things; and, *affective faculties*, seek or avoid them.
      - of their organ
      - of their source
      - of modifying circumstances
      - of their appreciation, *a priori*.
    - 3d Genus—*Motions*:—approaching or recedent.
      - natural station
      - solipede
      - kneeling
      - seated
      - on the head
      - recumbent
      - walking
      - leaping
      - running
      - swimming
      - mechanism of the superior limbs.
    - 4th Genus—*Expressive phenomena*—enabling man to communicate with his fellow creature.
      - gestures
      - voice
      - speech.
    - 5th Genus—*Repose of the functions of relation.*
      - sleep

DIFFERENCE OF SEXES.

- **SECOND CLASS.** FUNCTIONS WHICH SERVE FOR THE PRESERVATION OF THE SPECIES.
  - Some require the concourse of the two two sexes;
    - Copulation
      - action of the male
      - action of the female.
    - Fecundation
      - action of the male
      - action of the female
      - system of fecundation
        - *epigénèse*
        - evolution
  - Others are exclusively imparted to the female.
    - Development of the egg in the uterus.
    - History of the membranes of the fœtus.
    - Physiology of the embryo, and of the fœtus.
    - Of gestation.
    - Of labour.
    - Of lactation.

- **APPENDIX.**
  - Ages.
    - 1s. Infancy.
    - 2d Infancy.
    - Adolescence.
    - Manhood.
    - Old age.
  - Individual differences.
    - Idiosyncrasies.
    - Temperaments.
    - Constitutions.
    - Habits.
    - Human races.
      - Caucasian.
      - Œthiopian.
      - Mongolian.
  - Sympathies.
  - Synergies.
  - Death
    - Natural.
    - Accidental.
  - Cadaveric Phenomena.
  - Putrefaction.

inked together, in *circulum abuentes* (*Hipp.*), that, in my opinion, it is almost impossible to establish a perfect arrangement; however, the order in which the functions of man should be studied, is not altogether indifferent; that which is followed at the *Ecole de Medicine* in Paris, appears to me preferable to any. The classification of Professor Richerand is simple and natural: it views the functions nearly in the same order as that of their development throughout the divers classes of the animal kingdom. We shall merely add a few modifications in their subdivisions.

[See the Table.]

FIRST CLASS.

LIFE OF THE INDIVIDUAL.

FIRST ORDER.

FUNCTION OF NUTRITION.

CHAP. I.

DIGESTION.

Digestion is that function by which external reparative substances (*aliment* and *beverage*) are admitted into an apparatus of organs, to be therein converted into a particular organic matter, calculated to make up for the losses of the economy, and to provide for its increase.

Its history will include—1st, The study of food and drink; 2dly, a few considerations on the apparatus of the function; 3dly, and finally, its mechanism.

ARTICLE I.

Sect. I.—*Of Aliment.*—Under this head is understood all natural substances, either solid or liquid,

which, being submitted to the action of the digestive organs, are rendered fit to repair the solid part of the blood. A number of medicaments are nearly in the same condition; in general, however, they are said to resist digestive action.

The most natural division of food is drawn from its vegetable or animal nature, although some physicians consider these two kingdoms as similar. It is an indisputable fact, however, that vegetable food does not admit of being so perfectly triturated as animal, that its nature is less approximated to that of man; consequently, that it requires to be taken in a greater quantity, and requires more capacity in the digestive apparatus.

Man, in spite of what some philosophers have said, is essentially *omnivorous*, and, most frequently, his taste will lead him to associate the two diets. But as the one is remarkably stimulating; and the other, on the contrary, debilitating, he gives them in turn the preference, according to the different parts of the globe he inhabits. Thus, a vegetable diet is more generally resorted to, under the ardent climate of the equator; whilst, towards the frigid polar zones, it is at the expence of animals that man supports life.

The nutritive principles in animals are: fibrin, gelatin, albumen, osmazome, caseum, butter, fat, &c. Those, in vegetables, are: sugar, fecula, gum, mucilage, acids, oils, jellies, gluten, tanin, &c.; sea-

sonings only are borrowed from the mineral kingdom.

The ancients, according to *Hippocrates*, admitted, in all kind of aliment, of an alimentary matter invariably the same: *Halle* was the first who rose against that opinion. The question, however, remained unresolved—when chemists, *Marcet* in particular, by demonstrating that chyle, essentially differed, according to the nature of food, put an end to all disputes.

Sect. II.—*Of Beverages.*—Under this denomination is included, every liquid received into the digestive organs, the end of which is to repair the fluid part of the blood: they are taken to quench thirst, to dissolve solid food—finally, to stimulate the gastric organs, and even the whole economy.

Water has been for a long time the first, and even the only beverage used by animals. But now, man has succeeded in procuring for himself a variety of drinks, which he uses, it is but too true to say, more with a view of gratifying his palate and sensuality, than to supply the common wants of nature. They may be divided into three classes:—

The first includes water, and all kinds of beverages, whose base it forms; containing neither aromatic, or alcoholic principle. The second, aqueous drinks, loaded with aromatic principle. And, finally, the

third comprehends all those whose active principle is alcohol.

ARTICLE II.

Of the Digestive Apparatus.

In man, it begins at the head, crosses the neck, the thorax, fills up nearly the whole cavity of the abdomen, and finally terminates at the anus. It presents the following parts for consideration:—

1st. *The Mouth* is a parabolic cavity, in which, or around which, we meet with the gustatory organs with those of mastication and of salivation. In front are the *lips*, veils remarkably moveable, separated by a transverse fissure, which forms the entrance of the digestive canal: backwards is the *isthmus of the throat*, which leads into the pharynx, covered in the natural state by the *velum palati*, which is elevated during the time of deglution, to conceal the *fossæ nasales*. Above, is a solid paries, called the *palatine vault*; below, we find the tongue, the organ of taste. On the sides, are the the cheeks and the salivary organs. Finally, the mouth presents the masticatory apparatus, which is composed of two jaws: the one *superior*, the other *inferior*. They are articulated in such a manner as to admit of motions of elevation, and of depression, communicated to them by powerful muscles. Behind the lips, each of these bones presents a pro-

minent ridge, in which the *teeth* are implanted in a semi-circular order: each jaw contains sixteen, which are divided according to their respective situations and uses, into *incisive, canine,* and *molar*. It is by their grinding the food that the act of mastication is accomplished.

2dly. *Pharynx* and *Œsophagus* are the organs intended to transmit the food from the mouth to the stomach. They consist of a long muscular membranous canal, which by its superior portion communicates with the mouth and the nasal fossæ, and inferiorly with the stomach, subsequently to its having passed through the diaphragm. Its parieties consist of an external muscular layer, and of an internal mucous membrane.

3dly. *The Stomach* is a kind of reservoir, more or less capacious, which begins the intestinal canal: it is situated immediately below the diaphragm. In form it resembles a truncated cone. On the one part it receives the inferior extremity of the œsophagus; on the other, it is continuous with the intestine by a contracted orifice provided with a valve (*the pylorus.*) Its organization consists of an internal mucous membrane, of an external serous membrane, and of a muscular coat, interposed between these two; the different fibres of which are, some circular, others longitudinal or oblique—the stomach receives a considerable number of vessels and nerves. It is in this viscus that the principal phenomena of digestion take place.

The Intestine is a long canal continuous with the stomach, and terminates at the anus. It is composed of different portions — 1st, The *duodeum*, admitting of considerable dilatation, and on this very account called *ventriculus succenturiatus*; in its interior the biliary and pancreatic ducts empty themselves: lower down we meet with the *small intestine*, properly so called: the circumvolutions of which, floating in the abdomen, nearly fill up that cavity. In this portion *chylous absorption* takes place. Next comes the *large intestine*, which includes the *cæcum*, the *colon*, and the *rectum*, terminating between the buttocks, by a contracted orifice, provided with a sphincter. This large intestine acts both as a reservoir and as an excretory duct for fœcal matters. A valve, the *ileo cæcal*, is observable at the point where it unites with the small intestine, and it is so disposed as to prevent all retrograde motion, when the alimentary residue has reached the intestine.

The intestinal parietes are inwardly formed by a mucous membrane, outwardly by a serous one. Between the two, a muscular coat is interposed, composed of circular and longitudinal fibres, which in the large intestine reunite in three distinct layers.

The interior of the digestive tube is lubricated by a mucous fluid, exhaled from the membrane of that name, and from its follicules. This exhalation is very active in the stomach, particularly during digestion. It

is productive of an abundant supply, of a viscous, greyish insipid fluid, called *gastric juice,* and to which, since the time of *Spallanzani,* has been attributed the property of dissolving food.

In man, the intestinal canal is reckoned to be from six to seven times his height; in carnivorous animals, only from three to four; in herbivorous, from nine to eleven—taking, however, for length of the body, the distance between the mouth and the anus, and paying no regard to the extremities. These differences, which proceed from the more or less reparative or refractory qualities in the food these animals make use of, afford us an additional proof that man is omnivorous.

Such is a succinct description of the digestive canal; but several other organs are annexed, and powerfully concur with it in the important act of digestion; these organs form the apparatus of particular functions. Here we shall confine ourselves to pointing them out, and in the chapter of secretions we shall lay down every particular which relates to them. These annexed or auxiliary organs of the digestive apparatus are the salivary glands, and the divers granulations, pouring into the mouth a viscous liquid, with which the aliment is incorporated in the act of mastication; the amygdalæ, or tonsil glands, and the follicules at the base of the tongue, produce this fluid, which assists the passage of the alimentary matter through the isthmus of the throat: Finally, the pancreas and the liver pour into the

duodeum, humours indispensable for the conversion of food into a nutritive element.

The gastro-intestinal canal is contained within the *abdomen*, a cavity, whose parietes essentially muscular, powerfully concur to effect digestive excretions.

ARTICLE III.

Mechanism of Digestion.

Hunger.—The want of nourishment is grounded on the necessity of making up for the losses which the body incessantly undergoes. Hunger every one is acquainted with by his own observation; it is an internal sensation that warns us of that want of nourishment which we stand in need of admitting of various dedegrees. This sensation, slight at first, assumes the name of appetite; afterwards it becomes urgent, irresistible—and this is hunger, properly so called: it assumes the character of pleasure when gratified, and that of pain when resisted.

Hunger is felt, after the stomach has remained for some time in a state of vacuity: it is appeased the moment food is admitted, and is even succeeded by satiety. Numerous circumstances will modify this sensation in a very remarkable manner; more vivid in the infant than in the adult, it becomes languid in old age, and is sometimes even completely lost. It varies according to the idio-syncrasics, the state of health or

of disease, according to climate and seasons; finally, as habit may have imparted to it rather a regular periodical character: Dissipation, amusement, intellectual labour, the use of opium will blunt it, and even occasion it to be completely destroyed.

If by the effect of any circumstance whatever, or by that of the will, hunger is not satisfied, the stomach contracts, and a tearing sensation, which induces us to overcome all kind of disgust is felt; the intellectual faculties become benumbed, every function is in a languid state, except absorption, which borrows juices from all the parts, to return them to the circulatory torrent; and this accounts for why emaciation is so promptly produced.

Divers hypotheses have been set forth to account for the probable cause of hunger. *Plato* attributed it to a determination of the soul; subsequently to him, the frictions of the parietes of the stomach, the acrimony of the gastric juice, the contractions of the diaphragm, the lassitude or weariness of the stomach, the deficiency of nutritive juices, have been in turn resorted to. But, does it not proceed from a kind of understanding or correspondence existing between this viscus and the other organs, whose wants it is commissioned to supply?

Of Thirst.—Thirst again is a special, internal sensation, distinct from the first: Similar to hunger in this respect, it assumes a character of pleasure or of

pain, accordingly as it is gratified or resisted; similar to hunger also, it admits of numerous degrees of variety, influenced by divers circumstances. Opium, which, as we have just seen, is hostile to hunger, increases thirst, &c. But here, habit has no longer the same influence; nothing, in fact, is certain with respect to the periodical return of thirst: It manifests itself, with more or less ardour, in a proportional ratio, as the want of repairing the fluid parts of the blood has become more or less pressing.

Whenever the want of drinking is resisted, thirst becomes proportionally more and more urgent—a sensation of dryness and ardour in the mouth, throat, and stomach, superveness; mucous secretions are at an end; the organs become burning and excited to excess, they inflame: finally, Death, attended with furious delirium, and the most excruciating pains, (of which the shipwreck of the *Medusa* affords so lamentable an instance,) is the unavoidable consequence.

With respect to the proximate cause of thirst, as much may be said as with respect to hunger—it probably proceeds from a similar cause. Some authors place its seat in the pharynx, others in the stomach. But an important fact, that ought not to be overlooked, is, that thirst may be quenched by injecting fluid into the veins, as has been proved by *Dupuytzen's* experiments.

Prehension of Food.—It is by the means of his su-

perior limbs, assisted or unassisted with particular instruments, that Man conveys alimentary substances to the mouth; for the reception of which, this cavity opens by the separation of the two jaws. If a moderate opening only is required, the inferior jaw alone is depressed; but, if it requires to be more considerable, the superior is observed to be thrown backwards with the whole of the head. Its elevation may then be calculated nearly at a fifth or sixth part of the depression of the inferior jaw. *Boerhaave* attributed this elevation of the superior jaw to a slight contraction of the extensor muscles of the head; *Ferrein* to the action of the posterior fasciculus of the digastric muscle, assisted by the thyro-hyoïdeii. Such also is the explanation given by Bichat and Richerand. Finally, Chaussier is of opinion, that this is a mechanical effect arising from the disposition of the temporo-maxillary articulation.

In every instance, the following is what occurs during the prehension of food: 1st, The mouth receives it passively; 2dly, an action of the lips is observable, and to this act is referred suction, in performing which the infant first secures the nipple with his lips. Next, by a deep inspiration, he forms a vacuum in his mouth, by applying the velum palati over the posterior opening of the nasal fossœ; the cheeks and tongue assume a spoon-like form, to convey the milk into the pharynx. Thirdly, and finally, in other cir-

cumstancecs, prehension of food is attended with biting, to divide the alimentary mass into fragments.

Of Mastication and Insalivation.—Operations by which the aliment is triturated, softened, and reduced into a kind of pulp. As soon as the alimentary substance has been received into the mouth, this cavity is closed by the lips being brought together, and by the depression of the velum palati, then the jaws are brought to act, the inferior being alternately depressed and carried back against the superior, which it strikes in the like manner as an hammer does the anvil. The food, incessantly brought back between the teeth by the joint action of the cheeks and tongue, is divided and lacerated by the incisive and canine teeth, and ground by the molares; for which purpose, to the alternate motions of depression and elevation, a third, horizontal motion, is joined, perfectly calculated to effect trituration.

During this act, saliva, the secretion of which is stimulated by the motions of the jaws, as also by the contact and savour of the food, abounds in the mouth, and gradually mixes with the alimentary mass as it is triturated; it penetrates into it, and converts it into a soft paste. This impregnation, independent of its facilitating trituration, by softening the alimentary mass, renders it easy of deglutition. In mastication, the inferior jaw represents a lever of the third order, the point of rest of which is at the temporo maxillary articula-

tion, the resistance more or less distanced from the chin, and the power represented in the middle by the temporal masseter, and internal pterygoïdian muscles. However, in some cases, the food is brought on a level with the insertion of these muscles; that is to say, between the molar teeth: the jaw, in this case, is converted into a lever of the second order. The efforts resulting from the shock of the two maxillaries are disseminated throughout the cranium and the face, by the vertical apothyses of the superior maxillary, the orbitary and zygomatic portions of the check-bone; and, finally, by the vertical branches of the os palati.

Of Deglutition.—This name is given to the passage of the food from the mouth to the stomach. We may, with *Magendie*, divide it into three periods.

1st. When the food has been completely reduced into a soft paste, it collects in the form of a ball over the surface of the tongue: then mastication ceases. The point of the tongue is applied against the palatine vault, and consequently forms an inclined plane towards the pharynx. Next, successively contracting from the point towards the base, it presses the food against the palatine vault, and forces it into the isthmus of the throat. The velum palati then rises in such a manner as to form a continuation with the vault, and the body of the tongue, rising at the same time, propels the alimentary substance into the pharynx.

2dly. The mass has no sooner crossed the throat,

than the pharynx, whose capacity is transversely increased by the stylo-pharyngeii muscles, is elevated by its proper muscles, and, with the larynx, by the muscles of the super-hyoidian region, which then take their point of rest on the maxillary bone; the results of this abrupt contraction is, that the pharynx, being considerably shortened, draws with it, in consequence, the alimentary mass, which crosses the whole extent with such rapidity, that *Boerhaave* compared this second period to a kind of convulsion. During this second time, the aliment cannot re-ascend into the fossa nasalis, because its opening is obstructed by the velum palati; nor can it return to the mouth, being prevented from taking that direction by the elevation of the base of the tongue. Finally, neither can it possibly penetrate into the larynx, on account of, on the one hand, the glottis being perfectly contracted by the effort of its own muscles; and, on the other, the epiglottis being depressed by the very fact of the larynx being drawn towards the root of the tongue. As soon as the aliment has reached the inferior extremity of the pharynx, it again descends, and draws the food along with it.

3dly. Finally, the food, propelled by the action of the pharynx, gradually descends into the œsophagus, by the alternate contractions, upwards and downwards, of its circular fibres, whilst, at the same time, the longitudinal fibres of this organ contracting, draw

this canal over the aliment, upwards and downwards, to shorten as it were the space it has to overrun. Gravity is not an essential condition for deglution, but undoubtedly it promotes its progress; the mucus with which the interior of the œsophagus is lubricated, also assists the gliding of the aliment, which, however, is always slowly effected. Finally, when it has reached the stomach, the inferior extremity remains contracted for some time, to prevent a reflux.

It is generally admitted, that the deglutition of fluids is attended with more difficulty than that of aliment. *Magendie* is of a contrary opinion. With respect to the deglutition of air, it is effected with much difficulty, and is not in every body's power: it requires habit.

Accumulation of Food in the Stomach.

A series of alimentary masses being successively conveyed to the stomach by deglutition, and this viscus being but very slightly pressed upon by the neighbouring organs, gradually distends, in proportion to the supplies it has received. The contraction of the inferior extremity of the œsophagus, and that of the pyloric orifice, which increases in a proportional ratio with the state of the fulness of the stomach, retain the food. When this reservoir is sufficiently distended, that is to say, when it contains as much food

as it can possibly admit, hunger is satisfied, and is soon succeeded by a sensation of satiety, even of disgust. The abdominal viscera are pressed downwards; hence, the want of passing urine, the diaphragm is pressed also, respiration becomes short and frequent, the abdomen stretched; heat soon appears to forsake the extremities, andto fix in the epigastric region: a shivering is felt, and warns us that digestion is about to commence.

Chymification.—As soon as food has been accumulated in the stomach, its mucous membrane assumes a deep red hue; it fills itself with a larger quantity of blood; the follicular and perspiratory secretions become more active; and the gastric parietes, being closely applied to the alimentary mass, compress it in every direction; after an hour, or nearly that time has elapsed, contractions begin in the pyloric portion of the organ, which, soon extending to all the parts of this viscus, impart to it alternate motions, called *peristaltic*. These contractions progressively increasing in energy, communicate to the food oscillatory motions in divers directions, tending to promote its softening and its impregnation with the drink, and particularly with the gastric juices transuding from all the parts of the stomach. If to this we add that the alimentary mass is submitted to at least thirty-two degrees of heat, we shall possess all the circumstances which concur to

alter the aliment, and convert it into an homogeneous greyish pulpous mass, called *chyme*.

Experience has taught us that chymification is effected by thin layers, from the circumference to the centre, that these parts are successively directed towards the duodeum by the peristaltic contractions of the stomach, the pylorus gaping to give passage to those that are properly chymified; contracting, on the contrary, if this process is not complete. At every expulsion the stomach contracts over the remaining part of the aliment, and gradually effects its conversion by the same mechanism; a fact, rather worthy of remark, is, that it is particularly in the pyloric portion chymification takes place.

It is impossible to fix in a general manner the time required for this operation; it considerably varies, according to the power of the digestive organ, the nature, quantity, and degree of mastication of the food. *Magendie* has proved by experiments that that procured from vegetables is slower of digestion, more difficult and more incomplete. Professor *Dupuytren* has remarked, in cases of artificial anus, that in proportion as the food contained less of nutritive principles, the sooner it was expelled; however, generally speaking, it will seldom remain in the stomach beyond four or five hours.

Authors have not restricted themselves to the obser-

vations of facts, they have endeavoured to explain them. But the greater part of the hypotheses that have been set forth on this subject, are but as many numents erected to aetual delirium of the imagination.

1st. *Coction,* broached by *Hippocrates,* has been taken, in the etymological sense of the word, by physicians, who followed him, and who maintained that actual ebullition took place in the stomach.

2dly. *Fermentation,* adopted by *Vanhelmont,* and much in vogue at the epoeh of *chymism;* a kind of animal leaven was supposed to exist in the stomach.

3dly. *Putrefaction,* evidently proved false by *Spallanzani,* who has demonstrated on the contrary, that digestive action ehecks the progress of putrid fermentation.

4thly. *Trituration* actually takes plaee in the *gallinaceous* speeies, wherein it is substituted for mastieation. The organization of the stomaeh of man opposes itself to the admission of such an hypothesis.

5thly. *Maceration,* professed by *Haller*: this doetrine has not survived its author.

6thly. *Dissolution,* is generally attributed to *Spallanzani.* Stomaehal digestion, aceording to this author, results from the dissolution of the food by a peeuliar humour, ealled *gastric juice,* and which he pretends is collecting in the stomach during its state of vacuity. This naturalist affirms, that he has produeed

artificial digestion by moistening aliment properly masticated, with gastric juice, being careful to keep the whole in a suitable degree of heat. This doctrine has been admitted by a great number of physiologists: *Viridet, Hunter, Dumas, Richerand,* &c.—but none of them agree with respect to the source and nature of this humour.

This doctrine has also a number of opponents; *Demontegre,* in particular, who was possessed of the faculty of vomiting at will, has ascertained that the humours contained in the stomach, in its state of vacuity, were nothing more than saliva, which had acquired a certain degree of acidity, by a commencement of the process of digestion. *Chaussier* positively denies the possibility of the artificial digestions, tried by *Spallanzani,* as well as the accumulation of gastric juice in the stomach: he merely admits that, during digestion, the stimulation produced by the food on the mucous membrane of the stomach, is productive of a transudation of juices, proper for chymification; let us observe that, to these juices are added, saliva, the mucous fluids of the mouth, of the pharynx, and of the œsophagus, drink, and a certain proportion of atmospheric air.

Nervous influence performs an active part in chymification, as has been proved in a most indisputable manner by the experiments of *Baglivi, Le Gallois, De Blainville, Dupuy, Hastings, Dupuytren,* &c. who have divided, or taken up the par vagum. From recent experiments

undertaken, with the same view, by *Wilson Philip*, *Edwards*, and *Vavasseur*, it appears, that in order to chymification being completely suspended, the extremities of the nerves should be divided. A very remarkable fact, however, which has been observed by these experimentors, is, that the power of digesting may be restored by substituting a galvanic current for the nervous. Does electricity, in truth, act the same part in the animal economy as in chemical combinations?

Let this be as it may, it is an evident fact, that by the concourse of the action of the stomach, of the numerous juices abounding in this cavity, of animal heat, and of nervous influence, the alimentary mass, of whatever kind it may be, is converted into chyme. This substance is a greyish viscous matter, of a sweet savour, which most frequently is acid, but sometimes alkaline. *Marcet*, who has recently analysed it, has found in it albumen, animal matter, and a few saline traces, generally consisting of lime, an alkali, &c.; he has also found it to differ as it proceeded from vegetable or animal substances: in the latter case, it always contained much less carbon. It is highly probable that its nature must vary according to that of the food it proceeds from. In an epileptic subject, who died suddenly, after having taken some milk, *Lassaigne* and *Leuret* ascertained, that the chyme contained lactic acid, sugar

of milk, albumen, an acid yellow fat matter, another similar to caseum, muriate and phosphate of soda, with phosphate of lime.

Accumulation of Chyme in the Duodeum.

Chyme, as it is gradually elaborated by the stomach, is successively conveyed to the duodeum, towards which it advances as a new supply is given; this intestine dilates, and chyme accumulates in it. The contraction of the pylorus prevents a reflux into the stomach, and although nothing seems to prevent its entering the jejunum, it generally enters this tube only after having undergone a new elaboration.

Chylification—As soon as the chyme reaches the duodenum, it causes a concentration of action in this canal, the mucous membrane becomes impregnated with a larger quantity of blood, the perspiratory and follicular secretious actively increase, the excitation is extended to the choledochal and pancreatic ducts, and instantaneously determines the afflux of a greater quantity of bile and pancreatic juice; from this very moment these humours incessantly moisten the chymous mass. This impregnation, gradually effected from outwards to inwards, is also promoted by the peristaltic motions, which cause the matter to proceed slowly through the intestine.

The moment chyme is mingled with bile and pan-

ereatic juiee, it undergoes a great alteration*: it assumes a bitter savour and a yellowish hue; if it proeeed from fat matters, filaments, aecording to *Magendie*, are seen to form on its surface, and beeome quiekly attached to the valves of the intestine: this is, aeeording to this experimentor, *chyle*, in its rough state. In every other ease the ehymous mass is eovered with a semi-fluid greyish layer, whieh adheres to the intestinal mueous membrane: this new matter does not preeisely present the aspeet and the eomposition of ehyle, but most undoubtedly it eontains the elements of it.

Sueh are the phenomena observable during the partieular elaboration, by which chyme is eonverted into ehyle. If we attempt to penetrate deeper into the very essenee of this aetion, we fall into sueh profound obseurity, as to paralyse the senses, and drive us onee more to the wandering eonjeetures of imagination. All we positively know in this respeet is, that the separation of ehyle ean only be effeeted by the mixture of bile, and panereatie juiee with ehyme; however, we shall find in the following lines, that *Lussaigne* and *Leuret*, in some degree, deny this assertion. In a memoir, whieh they have lately presented to the Institute, they eonsider digestion in the stomaeh as an aetual dilution of the aliment, by the gastrie aeid juiees. In every instanee, they have met with ehylous partieles already formed in the stomaeh of mammiferi; they have even deteeted them in the artificial digestions of

Spallanzani. They are of opinion that bile merely favours their formation, by atennuating and dissolving the substances which had not been sufficiently dissolved by the action of the gastric juice; finally, after the application of a ligature to the ductus choledochus, chylification has been found to be continued. *Brodie,* it is well known, obtained quite different results.

The ancients considered bile as a kind of soap, intended to incorporate the fat parts of the food with the aqueous. *Boerhaave* says it mitigates the acidity of chyme. *Chaussier* believes that it is destined, in common with other juices, to dissolve aliment, and to separate it into chyle and fæces. In modern times bile was supposed to separate into two parts; the one alkaline, which unites with chyle, the other a sharp bitter, which mixes with the excrements. With respect to pancreatic juice, some consider it as intended to precipitate the alkali of the bile; others pretend it has no other use than that of diluting cystic bile.

Chyle considered in itself.—Chyle is a milk-white fluid, transparent in herbivorous animals, opaque in carnivorous; it has a sweet savour, and a spermatic smell; similar to blood, it separates into two parts: the one sero-albuminous, the other the coagulum, consisting of fibrine, of a colouring matter, and of a fatty substance. According to *Marcet,* that which proceeds from vegetable food, leaves a colourless clot, or nearly so, and re-putrefaction for a considerable length of

time ; contains but a small proportion of sub-carbonate of ammonia, and a larger quantity of carbon ; whilst that proceeding from animal food, deposits an opaque clot, of a light pink colour, which soon yields to putrefaction, contains a larger proportion of sub-carbonate of ammonia, less of carbon, and covers itself with a fatty substance, never met with in the first.

The course of Chyme in the small Intestine, and absorption of Chyle --The chyme gradually passes through the small intestine ; it stimulates the peristaltic contractions of that canal, and determines a more abundant mucous secretion, which is favourable to its progress. During its course, it gradually undergoes the changes already pointed out ; and the exterior, greyish semi-fluid parts, are absorbed by the chyliferous vessels, with which they come in contact. By this absorption, which shall be further explained, (in treating of that function), chyme becomes more and more concentrated, being robbed of its nutritive principles, so that, on approaching towards the end of the ileum, its consistency is considerably increased—its chylous layer has disappeared ; in a word, it is reduced to an excrementitial residue.

Action of the large Intestine.—It is by means of the peristaltic motion that the end of the small intestine forces the alimentary residue into the cœcum ; the ileo-cœcal valve, as we have seen, is disposed in such a manner as to leave this passage free, and to prevent

all retrograde motion; the matters necessarily accumulate in the cœcum, as much on account of this organ being inferiorly situated, as on account of the extent of its cavity; after, having remained there for some length of time, their contact stimulates that kind of reservoir to contraction, and in such a manner that the excrement is directed towards the colon; this last organ in turn is roused into action, and progressively propels the fæcal matters into the rectum, where they accumulate. The fluids exhaled on the mucous surface facilitate the progress.

During their passage through the large intestine, the fæces are robbed of their most fluid parts, and acquire a degree of consistency and solidity, more or less considerable. *Adelon* admits of a new conversion of the alimentary matters, in this organ; but physiologists consider this as a simple concentration of the chymous residue. *Berzelius*, *Vauquelin*, and *Thenard*, have proved, by analysis of the stercoraceous matter, that it contains water, albumen, animal, and vegetable fragments, silicium, sulphur, and different salts. In the large intestine, the excrement is generally attended with different gazes, azote, carbonic acid, carburetted, and sulphuretted hydrogen, &c.

Defication.—The rectum being remarkably dilatable, allows the fœcal matter to accumulate in considerable quantities. The sphincter, almost entirely influenced by the will, prevents their escape, and rids us

of the necessity of continually voiding them. During its continuance in the rectum, the stercoraceous residue acquires irritating properties; besides constantly increasing, both in quality and volume it becomes troublesome by its weight and quantity, which restrain the exercise of the neighbouring organs; from that moment a particular sensation is felt, which solicits its excretion; this sensation soon becomes unbearable, and overcomes all resistance of the will.

To satisfy this want, the body assumes a suitable position; at times seated upon a stool; at others, resting upon the hams, and inclined forward. The rectum, whose sensibility becomes stimulated, is roused to action, its lôngitudinal fibres tend to shorten it, whilst the circular fibres, contracting upwards and downwards, press upon the stercoraceous cylinder; the sphincter at the same time becomes relaxed, the muscles of the abdomen, conjointly with the diaphragm, which is depressed by a deep inspiration, press down the abdominal viscera upon the rectum; the elevator-ani, and the ischio-coccygean muscles, sustain and reflect every effort upon the fæces: thus compressed on all sides, the excrement is expelled through the anus, to which it moulds itself, and assumes the form known to every body. During this effort, *Halle* has remarked that the mucous membrane is outwardly protruded, in the shape of a circular swelling,and re-assumes, its natural station as soon as defecation is effected.

Of some unnatural Digestive Excretions.

In the natural state, the digestive functions take place in the manner we have just described; consequently, whatever differs from the natural order must be considered as morbid. However, during the course of his life, Man is frequently exposed to accidental excretions, which commonly rank amongst physiological phenomena; but, in common with most authors, we must give them a cursory glance.

1st. *Eructation.* Whenever the stomach contains any gazeous fluids, by reason of their specific gravity, they of course fill the superior region of that organ. The contraction of the inferior extremity of the œsophagus prevents them from ascending into that duct; but if by any circumstance whatever, that obstacle be removed, they instantly enter and escape by the mouth, producing a noise, occasioned by the vibrations in the edges of the aperture of the pharynx, whenever they are attended with vapours or liquids, the act receives the name of *regurgitation.*

2dly. *Regurgitation* is a phenomena similar to the preceding; with this exception, that, instead of gas, a fluid or food is returned. Regurgitation in most individuals is involuntary; some persons, however, have been known to produce it at will subsequent to their meals, and to use this faculty to effect as it were,

actual rumination. It occurs particularly, when the stomach is too much overloaded; however, it may also be observed when this organ contains nothing more than mucus. Its mechanism is perfectly similar to that of eructation; but individuals who produce it at will, are observed to take a deep inspiration to depress the diaphragm upon the stomach. Probably also they swallow a certain quantity of air; next, they contract the abdominal muscles upon this viscus, which they at the same time press with their two hands; then the food returns into the mouth, but the stomach undoubtedly does not remain passive in the act.

3dly. *Vomiting.*—This name is given to a convulsive excretion through the mouth, of matters previously contained within the stomach, and sometimes in other parts of the intestinal canal.

Nausea.—Under the influence of a disagreeable impression of the senses, under those of a titillation in the fauces, of the presence of irritating matters in the stomach, and of a distention of this organ; or, again, subsequently to having taken some emetic, &c. a particular sensation, indescribable, but known to every body by self-experience, is felt, and is commonly called *nausea*. This sensation is generally referred to the stomach, but from which part of the organ it orinates is yet unknown.

Mechanism of Vomiting.—The sensation that warns us of the want of vomiting is soon extended by a con-

traction of the stomach, and of the abdominal muscles; then the matters contained within the former overcome the resistance of the cardia, and are forcibly propelled into the œsophagus; their presence stimulates the instantaneous contraction of its fibres, but in a reverted order to that of deglutition, and the matters re-enter the pharynx: from the instant this organ contracts, the glottis collapses, and the velum palati assumes an horizontal position; the aperture of the pharynx gapes widely, saliva flows in abundance, the mouth widely opens, the head becomes slightly flexed over the chest, to shorten, as it were, the extent of the pharynx; then the matters are abruptly expelled, and frequently even to a considerable distance. The same effect is generally reproduced several successive times, respiration is suspended, the face becomes coloured, and the tears, flowing in abundance, trickle down the cheeks.

Such are the phenomena observed in the act of vomiting; but what is the active cause of it? The ancients attributed it to a convulsive contraction of the stomach, in a direction from the pylorus towards the cardia. *Bayle* first, and subsequently *Chirac*, after a few experiments, concluded, that vomiting was nearly the exclusive result of a compression of the stomach by the abdominal muscles. *Haller* defended the old doctrine. *Magendie* revived the opinion of *Bayle*, by a series of ingenious experiments; for instance,

he removed the stomach of a dog, and substituted in its place a pig's bladder, half filled with water, and re-united the parietes of the abdomen. Subsequently to this, he injected emetic into the veins, and vomiting took place. In another experiment he paralyzed the diaphragm by the section of the phrenic nerves; next, he removed the abdominal parietes, and no vomiting could be produced, &c. *Maingault* tried new experiments, which led to entirely opposite results to those of *Magendie*, consequently, to the consideration of the stomach being the sole active agent of vomiting. Finally, the recent researches of *Beclard* and *Richerand*, have brought back most physiologists to the opinion of *Magendie*. However, the experiments of *Maingault* have left the question undecided.

Digestion of Fluids.

The digestion of fluids is attended with very few peculiarities. On reaching the stomach they mix with the mucous fluids, are thickened, and soon acquire the same degree of temperature as the organ. In a remarkably short space of time, indeed, they completely disappear, being directly absorbed in the stomach; in order to reach the small intestine, they require to be taken in large quantities; and if they contain any alimentary particle, these are chymified and undergo the different digestive processes.

CHAP. II.

OF ABSORPTION.

The immediate end of this function is to collect, as well from outwards as from the very substance of the organs, and to elaborate, by means of particular vessels, divers materials, intended to make up for the losses of the blood.

Absorption is divided into *external* and *internal*; the first includes digestive absorption, the other *lymphatic*. We shall treat of each successively.

ARTICLE I.

External or Digestive Absorption.

1st. *Chyliferous Apparatus.*—The name of chyliferous apparatus has been given to an assemblage of particular vessels, situated between the two layers of the mesentery, extending from the small intestine to the reservoir of *Pecquet*, crossing in their course a number of small bodies, called the *mesenteric ganglia*: these vessels originate immediately from the free edge

of the mucous membrane. According to *Cruikshanks, Lewson, Hedwig, &c.* who pretend to have seen distinctly their orifices; or again, on the contrary, according to *Rudolphi, Meckel, Cuvier, &c.* they arise from a soft spongy substance, which admits of imbibition, and with which the mucous membrane is lined internally. The vessels, however, remarkably numerous and minute, are first situated in convoluted or ring-like order between the two layers of the mesentery, and pass over two or three rows of the mesenteric ganglia, previous to reaching the reservoir of Pecquet, in which they terminate by several large trunks. The chyliferous glands are remarkably numerous, their volume increases gradually as they recede from the intestine; irregularly lenticular in form, they are of a pale pink colour, and are generally considered as formed by a kind of convolution of chyliferous vessels. Some anatomists admit of small cells being interposed between the *vasa efferentia* and *vasa deferentia.*

The structure of chyliferous vessels consists of an external fibrous membrane, and of an internal membrane remarkably thin, in which small valvular folds are seen.

2dly. *Mechanism of Chylous Absorption.*—For the same reason that the disposition of the orifice of the chyliferous vessels has not yet been properly ascertained, we are completely in the dark with respect to their mode of absorption. It is evident, however,

these vessels perform a particular action, by which they borrow from the chyme the elements of a new fluid, as is proved by the formation of chyle; but what does this action consist of? The compression of chyle by the parietes of the intestine, which forces it into the gaping orifices, the capillary attraction of the chyliferous ramusculæ, a special sensibility in common with the organic contractility of the absorbing orifices, &c., have been in turn resorted to. A curious circumstance, however, has been observed by *Magendie*, that absorption is ~~contained~~ continued for some time after death.

3dly. *Of the Progression of Chyle.*—The chyle, which is thus absorbed by some kind of mechanism, travels through the whole extent of the chyliferous vessels, crosses the ganglia met in their course, and ultimately is emptied into the thoracic duct, jointly with the lymph. The causes which determine its course, are, 1st. The continuity of absorption; 2dly, the tonic action of the vessels; 3dly, the pressure of the abdominal viscera in respiration; 4thly, the pulsations of the neighbouring arteries. With respect to its rapidity, it is impossible to ascertain this with any degree of precision, because, most probably, it varies according to different circumstances. *Magendie*, for instance, who has made many experimental researches on this subject, has ascertained that the progression was at first generally slow, and that it became accelerated when the food had been abundant

and of easy digestion. We might also conclude from this observation, that the progress was less rapid the nearer we approach the inferior extremity of the small intestine; and according to the law for the progression of fluids in tubes of different diameters, chyle must gradually slacken its course, as it approaches the thoracic duct.

Numerous experiments and observations have proved, that chyle is elaborated throughout the whole extent of its course, and that it is gradually assimilated: white and serous at first, it becomes red and fibrous. *Tiedman*, and *Gmelin*, assert, that previously to crossing the ganglia, it is white, and never reddens by the contact of air, scarcely coagulates, and leaves no other deposit than a yellowish pellicle, that on the contrary, on reaching the reservoir of *Pecquet*, it assumes a pink colour, completely coagulates, and leaves a scarlet red cruor. This elaboration of chyle has generally been attributed to the mesenteric ganglia; but authors disagree with respect to the manner in which it is effected, and all that has been said on this subject,[e] sufficiently proves how little we know. Recently, *Tiedman* and *Gmelin* have pretended that the spleen concurs in chylification, by preparing a coagulable fluid proper to animalize the chyle by mixing with it in the thoracic duct.

Absorption of Fluids.—In treating of digestion, we have seen that fluids disappear with such rapidity from

the stomach, that very frequently they do not reach the intestine; therefore, as the chyliferous vessels do not open into the digestive organ, of course there must indispensably exist another order of vessels, by which this absorption is effected. Previous to the discovery of the chyliferous and lymphatic vessels, the ancients considered the veins as the agents of absorptions: subsequently this doctrine was laid aside, and all digestive absorptions were attributed to the chyliferous vessels—such is, to this day, the opinion of the greater number of physiologists. But lately, *Ribes* and *Magendie* have renewed the doctrine of the ancients, and are of opinion that fluids are absorbed by the mesenteric veins; on the one hand, they have seen injections propelled into the *vena porta,* transude into the intestinal canal, as had already been remarked by *Lieberkun*: On the other hand, they have constantly seen, in nice experiments, that coloured or odoriferous liquids, which they had introduced into the digestive canal of several animals, always found their way into the mesenteric veins, without the slightest trace of them being found in the lacteals. Finally, they claim the authority of *Boerhaave,* who affirms that he has seen the mesenteric blood become more liquid during the time fluids were digested; and that of *Flandrin,* who says he has remarked, that the blood in horses retained the odour peculiar to the forage they had fed upon; however, it appears highly probable that the veins are the agents or the absorption of fluids—at least, the essential ones

ARTICLE II.

Internal or Lymphatic Absorptions.

The end of this function is to collect from our organs a particular juice, known under the name of *lymph*, and to return it to the vascular system. The history of this kind of absorption, as far as it relates to its agents and mechanism, is involved in the deepest obscurity.

First, what are the vessels commissioned to perform internal absorptions? Since the discovery of the lymphatic vessels, these organs have generally been considered as the exclusive agents of this function; but, latterly, the venous absorption of the ancients has been revived by *Ribes* and *Magendie*, and particularly attached to internal absorption. From that time violent disputes have divided the votaries of these two doctrines, and, in the midst of these controversies, the greater number of physiologists remain in doubt; and until the point be finally settled, have admitted both of *lymphatic* and *venous* absorption.

These two orders of vessels, in fact, are extended from the surfaces, where absorption begins, to the centre of circulation; their origin, in the substance of our organs, appears to be the same: the fluids they contain, alike proceed to the lungs, there to be converted into arterial blood; finally, the materials of unnatural absorptions are also detected in both: for, if morbid

humours have frequently been met with in the blood, to this we may oppose the observations of *Desgenettes* and *Soemmering*, who have found bile in the lymphatics of the liver, and those of *Dupuytren*, mentioned by *Cruveilhier*, in which pus has been seen in the lymphatics adjacent to a suppurating tumour,

1st. *Apparatus of Internal Absorption.*—This apparatus consists of an assemblage of vessels, remarkably numerous and minute, that are extended from all the parts to the centre of circulation; these vessels, called *lymphatics*, are divided into two distinct sets in every organ: the one takes a superficial course, the other a deep one—their origin cannot be detected, and is unknown. Several anatomists admit of a direct and immediate communication between them and the arteries; others are of opinion, that they open upon their surfaces, and, in their substance, by gaping orifices. *Lieberkun* pretends, that their extremities terminate in a small spongy vesicle, to which an artery and vein are contained. Be this as it may, as soon as they become perceptible to the eye, they are seen to increase in volume, and to anastomose in a thousand different directions, in such a manner as to form networks in all the parts, particularly in the serous and tegumentary membranes. Finally, they recede more and more from their origin; crossing several series of ganglia, they meet in their course, and re-unite into two principal trunks: the one, the *thoracic* duct,

which at the same time it receives the chyliferous vessels, directs itself perpendicularly along the spine, and empties into the left sub-clavian vein; the other, considerably smaller, the *right lymphatic trunk*, terminates in the same vein on the right side.

The continuity of the lymphaties is interrupted by a multiplicity of ganglia, which, in general, are much larger as they approach nearer to the common trunk: their form is either rounded or elongated—they are contained within a small membrane, remarkably vascular. They were considered by *Haller*, *Albinus*, *Hewson*, and *Meckel*, as proceeding from a kind of convolution of the lymphatie vessels; *Malpighi*, *Nuck*, *Hunter*, *Cruikshank*, on the contrary, affirm, that the vessels are interrupted by the interposition of small cells.

With respect to the structure of lymphatic vessels, it is absolutely the same as that of the chyliferous—they have numerous valves.

Finally, the veins rank amongst the agents for internal absorption—but this shall be described in treating of circulation.

2dly. *Mechanism of Lymphatic Absorption.*—This absorption is known to exist more by the observance of its result than by its mechanism. This function, in fact, is completely hidden, so that, in this respect, we are once more reduced to conjecture. The materials, upon which it acts, are, 1st, The particles proceeding

from the decomposition of our organs, and this constitues *J. Hunter's* internal absorption; 2dly, the secreted recrementitial humours, serosity, synovia, particularly fat, the absorption of which is so very active during abstinence, &c.; 3dly, and finally, the most minute and assimilable parts of the excremential products.

The absorbing action of the lymphatic vessels is involved in still more obscurity than that of the chyliferous; this is saying, that it is perfectly unknown. Every hypothesis, which has been brought forward to account for the one has been applied to the other. Thus is it referred, 1st, To the influence of a pressure, which forces the lymph into the gaping orifices of the lymphatic ramusculæ; 2dly, to the capillary action of those diminutive organs; 3dly, to a kind of erection or alternate motions of contraction and dilatation in their extremities; 4hly, to a passive imbibition in a kind of spongy substance, from which these vessels are said to originate.

Let the mechanism of this absorption be what it may, the action of the lymphatic vessels is not restricted merely to the gathering of the materials we have just mentioned; but they also undergo, in these tubes, a special alteration, by means of which, they are converted into *lymph*. This humour, in fact, does not appear to be already formed, either at the surface or in the substance of our organs; however, it is

but right to say, that the ancients considered it as the white serous part of the blood, and that to this day—such is the opinion of the modern authors, who deny the power of absorption in lymphatic vessels.

Course of the Lymph.—This humour is propelled through the lymphatic vessels and ganglia, from their origin to their termination in the two subelavian veins, by an action perfectly similar to that of the progression of ehyle. The aetive agents of this motion are: 1st, The continuity of the supply; 2dly, the tonie aetion of the tubes; 3dly, the beatings of the neighbouring arteries; 4hly and finally, the contraetions of the muscles, or the motions imparted by the surrounding parts. *Malpighi* eonsidered the ganglia as so many small hearts or active powers, stationed in the course of vessels to promote the circulation. We must infer from the remarks of *Soemmering* and *Magendie*, that the progress of the lymph is remarkably slow, but whether uniform throughout its extent, has not yet been ascertained.

Lymph is a viseous fluid, slightly opaque, with little or no odour and savour, it separates into two parts: the one liquid, similar to the serum of the blood; the other solid, eomposed of reddish fibrous filaments. *Chevreiul* has found it to be eomposed of water, of fibrine, of albumen, of muriate and carbonate of soda, of phosphate of lime, and of magnesia.

4thly. *Mechanism of Venous absorption.*—Many physiologists maintain that venous blood is nothing more than the residue of arterial blood, that there exists a direct communication between the arterial and venous symptoms; finally, that the latter does not absorb. But, in the first place, the venous blood is more abundant than that of arteries, consequently it must contain something more than the residue of the latter; in the second place, venous absorption has been placed beyond a doubt, both by what has already been stated, and by the ingenious experiments of *Magendie*.

The materials of this absorption are the same as those of the lymphatic system: Its mechanism is undoubtedly the same, that is to say, we are perfectly ignorant in what it consists. *Magendie*, in a Memoir presented to the French Institute, pretends that this absorption is effected by capillary attraction. More recently, in a special work, *Fodere* maintains that this action consists of a mere imbibition. (The course of the venous blood will be studied in treating of circulation.)

The venous blood, submitted to atmospheric air, coagulates, and it disengages a considerable proportion of carbonic acid. It separates into two parts—the serum and the clot: 1st. The *serum* is a yellowish fluid, slightly viscous and alkaline. *Marcet* has found it to contain water, albumen, a muco-extractive matter, muriate of soda and of potash, sub-earbonate of soda,

sulphate of potash, phosphate of lime, iron, and magnesia. 2dly. The *clot* is a spongious mass, of a dark red colour, which, submitted to a small stream of water, divides into fibrine and cruor. It is considered by Brande and Berzelius to consist of animal matter, eombined with peroxide of iron.

All that has just been said with respect to absorptions, both internal and external, being perfectly applicable to morbid absorptions, it would be superfluous to give them a particular notiee.

Here absorptions end; in their history we have aequired a perfeet knowledge of the materials, which, by the next funetion are about to be eonverted into nutritive fluid, or arterial blood.

CHAP. III.

OF RESPIRATION.

The different fluids which are collected (as we have just seen) from all the parts by internal and external absorptions, are the only reparative materials of our economy. But previous to their becoming directly nutritive, they require the intervention of a special function, which converts them into arterial blood, by annexing to them a new element: Such is the immediate end of respiration.

ARTICLE I.

1st. *Atmospheric Air* is an elastic, colourless permanent, compressible fluid, forming a layer of forty-eight or fifty-one miles in depth, by which our globe is encompassed. This fluid is indispensable to the existence of every organized being, which it supplies with one of its constituent principles (*oxygen.*) It

will suffice to enumerate these constituent principles in order to be able to appreciate the part it performs in respiration. Atmospheric air is composed of twenty-one parts of oxygen, and of seventy-nine of azote; it contains also a few traces of carbonie acid, water, and divers foreign matters in suspension, and in addition, ealoric, electricity, and light.

ARTICLE II.

Apparatus of Respiration.—The lungs are the immediate agents of respiration; they consist of two vascular, spongious, extensible organs, situated in the lateral parts of the chest, whieh they completely fill: separated from eaeh other by the perieardium and the heart, they are united by a single ærial eanal, that, on the right side, is deeply divided into three tubes, that on the left into two only.

The organization of the lungs consists, 1st, of the *bronchii*, which eonstitute an essential part; they proceed from the traehea, and ramify almost ad infinitum to the parenehyma of the organ; aecording to *Malpighi*, they terminate by vesicles. *Helvetius* pretends that they freely open into the areola of the cellular tissue. *Willis* compares a bronchial extremity with a buneh of grapes. *Reisseissen* has found them terminating by a rounded imperforated extremity, &e. 2dly. Of an artery, called the *pulmonary*, attending the bronehii

throughout their divisions; and, according to *Malpighi* and *Reisseissen*, forms, by its ramifications, a beautiful net work over the bronchial vesicles. Other anatomists are of opinion, that these ramifications have a direct communication with the pulmonary veins, the exhalent vessels, and the bronchii. *Bichat* admits of the interposition of a capillary system. (It is, however, certain, that injections freely pass from the arteries into the veins and the bronchial tube.) 3dly. Of the *pulmonary veins*: the disposition of the furthest ramifications of these tubes is no more known than that of the arteries. 4thly. Of *bronchial arteries* and *veins*, of *lymphatic vessels*, and of *nerves*, for the purpose of effecting the nutrition of the organ. 5thly. Of *lamelar cellular tissue*, to re-unite all these parts into lobes, successively increasing in size. 6thly, and finally. Of a serous membrane, the *pleura*, by which the organ is enveloped.

The lungs exactly fill up the whole cavity of the pleura, as has been demonstrated by *Haller*, *Sauvages*, *Caldani*, &c.; and as, on the other hand, they have a free communication with external air, it necessarily follows, that they must follow every motion of dilatation, and contraction of the chest.

The *Thorax* is of a hollow conoïd form, the mobile parietes of which, with respect to the lungs, fulfil the office of bellows. The osseous frame consists of the dorsal vertebræ on the back part, of the ster-

num in front, and of the ribs on the sides; these different bones are articulated in such a manner as to admit of motion. A remarkable number of muscles complete the parietes of the thoracic cavity; according to the motions they impart, they may be divided into inspiratory and expiratory. From their alternate action, the mechanism of respiration results.

ARTICLE III.

Mechanism of Respiration.

It includes, 1st, the sensation of want of breathing; 2dly, the muscular action by which inspiration, and expiration are effected; thirdly, and finally, sanguification.

1st. *The Want of Breathing.*—No word can express this want, it consists of an internal special sensation, perfectly distinct from all other by its end. At first, it has something pleasing; but if by any means resisted, it becomes painful, and forcibly urges us to perform the action it claims; if prevented by any insuperable obstable, asphyxia is the unavoidable consequence.

This sensation is felt as soon as the air, introduced into the lungs, has been expended, say from sixteen to twenty times a minute: twenty-four according to *Davy*, and nineteen according to *Thompson*, the medium number is, twenty-eight thousand eight hundred times a day, for a man of middling stature.

2dly. *Inspiration.*—The name of inspiration is

given to that motion by which the chest increases its capacity, and air is drawn into the lungs. The dilatation varies according to the number of muscles that are roused to action. In slight inspiration, the two muscular portions of the diaphragm are depressed, and push downwards the abdominal viscera; consequently the vertical diameter of the chest is increased. In deeper inspiration, to the preceding motion, which can never be dispensed with, is added a transverse and anterio-posterior diametrical increase of the cavity; to produce this effect, the ribs of necessity, must be raised.

Haller and *Bichat* considered the first rib to be fixed by the scaleni muscles, as a point of rest upon which the intercostal muscles successively raised the others. *Hamberger* pretends that the internal intercostals are the expiratory muscles; he grounds himself on their direction. *Sabatier* would have it, that the first ribs were raised, the inferior depressed, and the middle ones directed immediately outwards. *Magendie* asserts, that the first rib is the most moveable; grounding himself upon its head being articulated with one vertebra only, and its having no inter-articulatory and costo-transversal ligaments; and that for the opposite reason the ribs must become less and less mobile, in proportion as they are more inferiorly situated. *Bouvier* thinks with *Magendie* that the first rib is the most moveable of all, but that the chest rises totally, and every part of it in a like proportion. Finally, in

deep inspirations to these motions may be added the actions of the grand dorsal, the pectoral muscles, &c. then the thorax assumes the greatest possible expansion; the anterior extremities of the ribs, raised and directed forwards, press the sternum in that direction, and impart to it a motion of elevation which is somewhat more extensive in its inferior part, so that this bone actually undergoes a slight oscillatory motion.

We have said, contrary to the opinion of *Vanhelmont*, *Vepfer*, *Mascagni*, &c. that no portion of air whatever could be traced in the cavity of the pleuræ; consequently, the dilatation of the chest must be immediately followed by that of the lungs. In fact, at the moment of inspiration, the glottis opens widely, and the air instantly rushes (as is proved by *Le Gallois*) into these organs, where it remains some time previous to its being expelled. It has not yet been ascertained if this fluid is directly distributed throughout the lungs, or in the same lobes only, if it proceed down to the furthermost bronchial extremities; or, again, if its progress be checked by that which had not been expelled during the previous inspiration.

The quantity of air drawn into the chest in a common inspiration, has been estimated at twelve cubic inches by *Goodwin*, at two according to *Gregory*, from sixteen to seventeen by *Cuvier*, and fifteen by *Borelli*; and this last physician pretends, that the inspiratory muscles are equal to a weight of thirty-two thousand and forty pounds.

3dly. *Expiration,* an internal, uncomfortable sensation: a kind of suffocation which soon warns us, that the air can no longer remain in the lungs, and forcibly urges us to expel it.

As soon as the powers, which had increased the capacity of the thorax, have ceased to act, and this cavity reassumes its primitive capacity, the diaphragm relaxes and ascends in the chest; the abdominal muscles press down the viscera of that cavity. If the ribs have been raised, they are mechanically depressed by the relaxation of the inspiratory muscles; and also, as *Haller* pretended, by the elasticity of the costo-cartilages, which, having undergone a slight eversion, have a tendency to return to their natural state. Finally, in deep inspirations, the abdominal muscles, the lumbar, sacro-spinal, and triangular muscle of the sternum with others, contract, and actively draw the ribs downwards.

At any rate, air, according to the ingenious simile of *Mayow,* is expelled from the lungs in the like manner as it is from a bellows on depressing the sides. Some physiologists, however, are of opinion, that the lungs take an active part in this act, which is very doubtful, as it is well known they do not leave the thoracic parietes.

The quantity of air expelled from the chest, is less than that which entered it, by two or four cubic inches, according to *Cuvier,*—by a fiftieth part, according to other experimentors. If the expiration be ever so forcible, there will always remain in the lungs, 1786

cubic *centimetres,* according to *Goodwin*; 1973, according to *Davy*; from sixty to a hundred cubic inches, according to *Cuvier*. But physiologists have obtained results infinitely various, according to age, sex, and constitution; so that they should not be taken in an individual, but in a general point of view.

The motions of inspiration and expiration succeed each other uninterruptedly, from the moment of birth to that of death. *Adelon* is of opinion, that these successive motions are entirely dependant upon the will, since each of them is under its influence, and that habit produces them almost irresistibly. But I consider that this author, in refuting the more or less incoherent hypotheses which have been set forth to explain the phenomenon, has substituted opinions quite as inadmissible.

In the first place, the influence of the will over the act of respiration, though very considerable, is nevertheless limited. Is it by the impulse of the will, that the new born infant, directs his respiration in the order it is to retain throughout the course of his life? Or can it possibly be in this subject, the influence of habit? On the other hand, it is not probable, that habit could actively keep up a function during sleep, besides a number of other circumstances in which the influence of the will has completely destroyed volition, most undoubtedly have a very considerable sway over

the muscular action of this function; but, I am of opinion, that it is not to volition that we should look for the immediate cause of the successive dilatation and contraction of the chest.

4thly. *Sanguificatian.* The essential end of respiration is to convert absorbed fluids, chyle, lymph, and venous blood, into arterial blood. These fluids rushing from all parts of the body to the right ventricle of the heart are propelled by this organ into the parachyma of the lungs, where consequently they come in contact with atmospheric air, in the manner we have already described.*

Previously to giving the theories of their conversion into arterial blood, let us first see upon what grounds these theories stand.

1st. *Alteration of Air.*—Air most undoubtedly yields a certain quantity of oxygen: thirteen parts to eighteen, according to *Goodwin;* a quarter only, according to *Meuzies*; three, to four hundred parts, according to *Davy* and *Gay Lussac.*

In the second place, *Bertholet, Nysten,* and *Dulong,* are of opinion, that it absorbs a small quantity of azote. Whilst *Spallanzani, Allen, Pepys, Humboldt,* and *Davy,* assert that, on the contrary, a small quantity is absorbed from it. By the recent experiments of *Edwards* we find, that the two facts may actually take

* We cannot admit with *Legallois,* that sanguification begins the very moment the three fluids come in contact.

place; but that, in the ordinary state, this gas performs no part in respiration.

In the first place, expired air draws along with it carbonic acid: eleven in a hundred parts according to *Goodwin*, five by *Meuzies*, and three according to *Guy-Lassac.*

Finally, in the fourth place, air absorbs a quantity of moisture which has been valued at 560 grammes by *Lavoiser* and *Seguin*, 590 by *Thompson*, for every day.

Alteration of Venous Blood.—This alteration comprehends those changes which fluids, that are to undergo sanguification, are submitted to, since they all unite in the venous blood, in the sub-clavian veins:

Difference of	Venous Blood.	Arterial Blood.
Colour	Dark Red	Scarlet Red.
Odour	Slight	Strong. (*Moscani* has made this odour a particular element of the blood.
Temperature,	31 deg. Rèaum	upwards of 32 Rèaum.
Capacity of caloric,	903 Davy.	913 Davy.
Specific gravity	1052 Davy.	1049 Davy.
Coagulation,	less sudden.	More sudden.
Serum,	less abundant.	More abundant.

The conversion of blood is instantaneous, as has been demonstrated by the experiments of *Goodwin*, and those (more ingenious still) of *Bichat*. This eminent physiologist adapted a cock to the trachea, another

to the carotid, and, accordingly as he checked respiration, or allowed it to be continued, he immediately produced venous or arterial blood; henee it is evident, that the conversion of blood is instantaneous, and immediately influenced by the approach of air.

Theories.—Amongst the aneients, some physiologists viewed sanguification merely as a meehanical action; they considered it as the result of an intimate mixture, which, in their opinion, took plaee in the pulmonary vessels; but for a long time, this opinion has been completely laid aside. There are two other theories by which modern physiologists are divided.

A. *Vital Theory.*—This theory rests on the following propositions: 1st. The quantity of oxygen used in sanguification is nearly the same, let the state of air be what it may; 2dly, at the approach of death respiration eonsumes less oxygen; 3dly, If eombustion existed in the chest, the lungs would soon be calcinated; 4thly, The seetion of the pneumogastric nerves retards, and ultimately suspends sanguification entirely. The analogy with other funetions in the economy, equally tending to the formation of a new fluid, &c. have also been resorted to; by this theory, it is admitted, that the conversion of venous blood into arterial is merely the result of the action of the lungs upon air, on the one part; and on the other, upon the fluids, about to be sanguified. Would it not be eorreet to say, with *Adelon*, that the ramuseula of the pulmonary veins seize at the

same time, both the oxygen of air and the fluids to be converted, and that by the combination of these two fluids, arterial blood is formed?

B. *Chemical Theory.*—By this theory it has been admitted, that the carbonic acid and water, which are disengaged during expiration, are the results of the combination of the oxygen of air, with the carbon and hydrogen of the venous blood, from whence proceeds the depuration of the latter, and its conversion into arterial blood; it is moreover supposed, that animal heat results from the caloric being disengaged during this combination. *Lavoisier* had at first only admitted of the combustion of carbon; but not finding in carbonic acid the whole quantity of the oxygen consumed in respiration, he subsequently admitted, with *Laplace*, the combustion of hydrogen. From the more recent experiments of *Davy* and *Guy-Lussac*, who have found that the whole quantity of oxygen absorbed, is equal to that contained in the carbonic acid, it is superfluous and idle to admit of this addition. Besides, the analysis of pulmonary exhalation having demonstrated that the elements are nearly the same as those of cutaneous perspiration, it is highly probable that their origin is the same.

To this theory has been objected every consideration upon which vital theory has been grounded, and moreover a few particular experiments: 1st. The quantity of oxygen expended in respiration is invaria-

bly nearly the same; but this is unavoidable, the fluids to be converted, being always nearly of the same composition.

2dly. Air, at the approach of death, yields less oxygen. But does this arise from the lungs refusing to act, or rather from their being less actively dilated, and hence the fluids to be combined coming but imperfectly in contact? In fact, it is from this cause that the imperfection of sanguification proceeds.

3dly. If combustion existed in the chest, the lungs would soon be calcinated. But, in the first place, this combustion is progressive, slow, and continuous; it acts upon very small isolated quantities, since the bronchial extremities, which are remarkably minute, do not communicate with each other; moreover, what is there astonishing in this combination, when oxides, salts, &c. are daily seen to form in our economy?

4thly. The strongest objection is that of the section of the pneumo-gastric nerves. This section, which has particularly been tried by *Dupuytren*, suspends, according to this physiologist, sanguification. Air, consequently, must lose less oxygen; and this, in fact, is what has been remarked by *Provencal*. But what can we conclude from these experiments? Is it not true to say, that the conditions for combination are destroyed, and that the fluids are no longer suitably connected for combustion to take place? Is this not at least what might be inferred from the experiments

of *De Blainville*, who affirms, that he has seen sanguification continued subsequently to the section of the par vagum, from those of *Dumas*, who, after this section has obtained the same results by inflating the lungs; and, finally, from those of *Brodie* and *Le Gallois*, who have kept up life for some time, and consequently sanguification, in beheaded animals, by the inflation of the lungs?

5thly. Finally, the experiments of *Spallanzani*, *Nysten*, &c. who have seen dogs, immerged in azote, disentangle a small quantity of carbonic acid, have been urged as objections; but this argument subsides of its own accord, when we recollect that the lungs are never completely freed of atmospheric air, let the expiration be ever so strong; besides, a few traces of it may be exhaled from the blood itself, since *Vauquelin*, *Brande*, and *Vogel*, have proved by their researches that this fluid contained some.

From what has been stated, we may conclude, that sanguification does not exclusively result from the vital action of the lungs, as most modern physiologists pretend, but actually from the chemical combination of the oxygen of air with the carbon; and it may be also, with a small portion of the hydrogen of the venous blood. I do not pretend with chemists, that the lungs are completely inactive, their state of vitality is evidently too indispensable for the accomplishment of the function, but they only act in presenting the elements

in the most favourable conditions for combination. With respect to the pneumo-gastric nerves, would it not be correct to say, that they hold this combination under their influence, in the same manner as an electric current might do?

A last question, which, in the actual state of the science, is not easily resolved, is to know, how the contact of oxygen with venous blood takes place. Some physiologists are of opinion, that it occurs in particular vessels; others pretend, that oxygen, drawn by its affinity, transudes through the pores of the bronchial parietes, to meet the venous blood. This last opinion appears to be most probable.

Before dismissing this important and grand function of respiration, it will be proper to mention how far it is connected with other functions: 1st. It is connected with smell, by drawing odours to the fossæ nasales, and expelling them; 2dly, We have seen that it is indispensable to suction, defecation, and vomiting; 3dly, It is not less connected with circulation, in fact it may accelerate or retard the course of blood; 4thly, and finally, It has immediate connexion with the voluntary motions, with every expressive phenomenon, and with the different mental emotions.

Efforts.—Bourdon and *J. Cloquet* have demonstrated that, the moment the body effects any effort whatever, respiration is suspended by the following causes: First, a deep inspiration is taken; next, and

as soon as the expiratory muscles contract to effect expiration, the muscles of the glottis become of themselves strongly contracted, so as to obstruct that opening, and to prevent the escape of air, in such a manner that the chest presents a solid point of rest, to the parts by which the effort is to be produced.

Coughing and Sneezing.—These two phenomena, result from an abrupt contraction (convulsive as it were) of the expiratory muscles, the glottis only contracts partially, and the air re-echoes in the nasal fossæ.

Gaping consists of a deep and involuntary inspiration, and of a protracted expiration; this phenomenon is expressive of *ennui*, or it denotes an inclination to sleep: it is attended with a considerable separation of the jaws.

Sighing also consists in a deep inspiration, which is slowly effected: this phenomenon of expression also is generally connected with some moral affection.

Laughter is another expressive phenomenon, consisting of a series of slight and jerking involuntary expirations, generally attended with noise; it results from a convulsive contractions of the diaphragm sympathetically communicated to the muscles of the face; hence the particular expression of merriment, and every feature becomes expanded: it, also proceeds from a moral cause.

Crying consists also of a convulsion of the dia-

phragm, equally communicated to the face, but the expression is quite different: crying is attended with a secretion of tears more or less abundant.

Panting is nothing more than common respiration accelerated.

Hiccup.—In this phenomenon we observe the instantaneous succession of an abrupt inspiration, during which the air is admitted with difficulty, owing to the spasmodic contraction of the glottis, and a convulsive expiration, during which air produces a peculiar noise.

It is needless to revert here to the properties of arterial blood, its composition is nearly the same as that of venous. Besides, we have pointed out what are the physical and chemical changes, by which, in the act of sanguification, the one becomes converted into the other.

CHAP. IV.

OF CIRCULATION.

Circulation is a function in which the blood, proceeding from the heart, is conveyed to all the parts of the body, and from hence returned to its centre. In Man we observe two circulations, the one includes the projection of the venous blood to the lungs by the venous heart, and the return of this blood converted into arterial, to the aortic heart: it is called *small circulation* or *pulmonary circulation.* The other comprehends the projection effected by the aortic heart, of arterial blood to all the parts, and the return of this blood converted into venous, to the pulmonary heart; this is the *grand circulation.* The agents of this continual motion, taken in a mass, have received the denomination of *circulatory apparatus.* In man it includes the heart, the arteries, the capillary, pulmonary, and general system, and the veins.

ARTICLE I.

Apparatus of Circulation.

1st. *Of the Hearts.*—The hearts are two hollow muscles, situate in the middle of the thorax, joined together on their back parts by means of a partition; each heart presents two cavities, the one situated at the base is the AURICLE, the other is called the VENTRICLE.

The *Red Heart, the Aortic Heart,* is situated rather more posteriorly than the right; the auricle is smaller than its ventricle, it is of an ovoïd form, smooth internally, excepting in its auricular appendix, where we meet with the carneæ columnæ; therein we also meet with the orifices of the four pulmonary veins, with the *ventriculo-auricular* opening; and on the partition that separates it from the right auricle is a depression corresponding to the fossa ovalis, the trace left of the *Botal* hole, which in the fœtus opens a communication between the two auricles. The *ventricle,* nearly pyramidal in form, presents in its interior a considerable number of carneæ columnæ. Two of these fasciculi, remarkable for their size, give rise to a multiplicity of small fibrous cords by which the *mitral* valves are confined. Superiorly we find the communication with the auricle and the aortic aperture; the auricular

opening is provided with two membranous folds faeing each other (the *mitral* or *bicuspid* valves). One of these valves, on being depressed, closes the mouth of the aorta.

The opening into the aorta, whieh is anteriorly situated, is provided at its eireumferenee with three *sigmoid* valves, the free edges of which are upwards.

The *Right Heart, Pulmonary Heart, Heart of the Dark-blood,* is situated rather anteriorly, and is similar to the preeeding. It presents an auriele at its base, and in the interior of this auriele, at the upper and baek part, is the opening of the vena-eava superior; at the lower part, that of the vena-eava inferior, the openings of the eardiae veins and a remarkable appendix of the earnea eolumnæ; inferiorly, we meet with the aperture of eommunieation with the ventriele, and inwardly with the depression known by the name of *fossa ovalis.* The ventriele is of a triangular form, is provided with a number of earneæ eolumnæ, three or four of whieh give origin to small fibrous threads by whieh the *tricuspid* valves are fixed. In the superior part, is found the communieation with the auriele provided with three membranous valves (*the tricuspid*), and also an opening leading into the pulmonary artery, the entranee of whieh is marked by three *sigmoid* valves.

These two hearts have a eommon organization: it eonsists of a serous membrane externally, inwardly of a smooth membrane, by whieh the valves are formed;

this membrane, however, somewhat differs in each heart. In the *red heart* it is sometimes continuous with the internal membrane of the aorta, and with that of the pulmonary veins—is brittle, readily admits of ossificaiton, and is not very extensible. In the *dark heart* it is continued with the veins of the body and with the pulmonary artery, is very extensible, not very brittle, and little disposed to ossification. Between these two membranes is interposed, the proper tissue of the heart composed of muscular fibres and fibrous zones. From the researches of *Gerdy*, the muscular fibres are seen to form kind of muscles differing in size, attached by their extremities to the fibrous rings of the ventricular and arterial orifices. Nerves, arteries, veins, and lymphatic vessels ramify in this tissue.

2dly. *Of Arteries.*—Arteries are canals of a solid organization, endowed with elasticity, originating by a large trunk from the base of each ventricle, intended to convey the blood submitted to the action of the heart to each capillary system; on the left is the aorta, on the right the pulmonary artery.

Arising from the left ventricle, the aorta almost instantly divides into two portions, the one ascending, for the neck, the head, and the superior limbs; the other, descending, for the chest, the abdomen, and the inferior extremities. Arteries are subdivided into trunks, branches, ramifications, and ramusculæ, &c. but there is no regularity in their origin. It is thus that ramifi-

cations, ramusculæ even, are sometimes seen to shoot off directly from large trunks. The subdivision of arteries has been carried very far by some anatomists. *Haller* reduced it to twenty and even less, for one large arterial trunk. Arteries thus subdivided assume, at times, a tortuous course, at others a straight direction; they anastomose, and these anastomoses are more numerous, as we recede further from the heart, and as the arteries become smaller. From this division of the arterial system results—a tree, the trunk of which is fixed to the aortic ventricle, whilst its branches ramify throughout all the parts of the body.

The pulmonary artery arises from the right heart, divides into two branches which attend the bronchii in their course, dividing and subdividing gradually as they penetrate into the substance of the lungs; in such a manner that the pulmonary artery represents another tree, the trunk of which rests against the right ventricle, and the branches are extended to the lungs.

Texture of Arteries.—Arteries are formed of three coats: of an *external*, cellular, of an *internal*, smoothly polished, and continuous with the internal membrane of the heart; finally, of a middle coat, the *membrane proper to arteries*, consisting of yellow circular or transverse fibres.

3dly. *Of the Capillary Systems.*—These consist of minute vessels, interposed between the arteries and veins, constituting by their reunion an intricate net work,

forming the parenchyma of our organs. We distinguish two capillary systems : 1st. The *general*, in which the arterial blood terminates and the venous begins. 2dly. The *pulmonary*. The venous blood is conveyed to this system to be therein converted into arterial. It is now generally admitted that the capillary vessels, the imperceptible extremities of the arterial subdivisions, fall back, to give birth to veins; that their anastomoses are so multiplied as to form an actual network in all the parts of the body. That from the more or less capillarity of these vessels, results at times the passage of the red globules of the blood (*red capillary vessels*); at others, only of the serous part of this fluid (*white capillary vessels*); and, finally, it has also been admitted that this system forms the communication between the arteries and the veins, effected by the means of arches at their commencement, and by transverse ramifications.

3dly. *Of the Veins.*—Veins are vessels commismissioned to return the blood; they originate by remarkably minute ramifications in the capillary systems: the veins are of two sorts, those of the body, which return the blood from the general capillary system to the heart, and the pulmonary veins, returning to the heart the blood, which has been converted into arterial, in the lungs. The venous system presents a succession of cylinders, diminishing in number and increasing in

size as we approach nearer to the heart. The veins of the body terminate in two large trunks in the right auricle. The pulmonary veins open by four trunks in the left auricle.

Texture.—We observe three coats in veins: an *external*, which is cellular, *an internal*, smooth, and continuous with the internal membrane of the heart; a middle one, *membrane proper to veins*, this is of a special nature, more elastic in the pulmonary veins than in any other of the system.

ARTICLE II.

Mechanism of Circulation.

Supposing the blood returned from the general capillary system, to be received into the right auricle, this last organ dilates and fills; to this succeeds its contraction, and the blood is thereby expressed (as it were) into the right ventricle. This ventricle in turn contracts, and the fluid is propelled through the pulmonary artery to its capillary system: herein this venous blood is converted into arterial to be returned to the auricle of the aortic heart, by the pulmonary veins; the same phenomena are observed with respect to the left heart—that is to say, a dilatation of the auricle, afflux of blood into its cavity, subsequently its contraction and a concluding dilatation of the ventricle; the ventricle fills, contracts, and the blood, propelled in the aorta, is conveyed to the general

capillary system. In this system the fluid undergoes another change: it is converted into venous blood, and returned to the right auricle, from whence we have supposed it to proceed.

Thus it is evident that the two circles of circulation form but one; that the termination of the former is the commencement of the latter. Let it moreover be observed, that they are accomplished at the same time; in fact, the contraction of one auricle coincides with that of the other, and the ventricles, the contractions of which alternate with those of the auricles, simultaneously contract: the name of *dastole* has been given to the dilatation of the ventricles; that of *systole* to their contraction.

The circulation has not always been so correctly understood. The ancients only admitted of an oscillation, of a balancing of the blood in the veins; and, as in dissection, they continually found the arteries empty of blood, they supposed these organs were intended to circulate a subtle fluid. Afterwards, the circulation of the blood, conveyed from the heart to the arteries, was admitted; and this fact, ascertained by *Gallen*, approaching so nearly to the real truth of the circulation, was the source of an error; for it was supposed that the blood was conveyed in the same manner from the heart to the veins in general. Harvey, in 1619—1628 published his discovery of the circulation.

If we now enquire into the powers which preside over the motion of the blood, and the direction it follows, we shall find the alternate contractions and dilatations of the heart to be the principal agents; the heart, in fact, acts as a kind of forcing and sucking pump. The blood could not follow any other course. During the dilatation of the auricle, the ventricle, which contracts at the same time, raises the valves, with which the auriculo-ventricular orifice is provided, of necessity the auricle must fill: the blood has no other issue. During the contraction of the auricle, the ventricle being dilated, it depresses the bicuspid and tricupid valves, and, in consequence of this depression, the arterial orifices become obstructed by a fold of the valves. The reflux towards the veins is prevented by the new blood which is continually arriving, and the auriculo-ventricular orifice being free, and directed from above downwards, the blood has no other issue, and of necessity must enter the ventricle. Some physiologists, however, pretend that there is always a slight reflux of blood from the auricles to the veins; others, on the contrary, are of opinion, that in the natural state this reflux never takes place.

The ventricle thus filled with blood contracts, and, as a natural consequence of that contraction, the valves of the auriculo-ventricular orifice are raised; in this act they prevent all communication between the auricle and ventricle: a reflux of blood consequently is put

beyond a possibility by the approach of a fresh supply received into the dilated auricle. On the other hand, the rising of the valves has left free, the gaping mouth of the arteries; the blood, consequently, is propelled through this orifice, by the contraction of the ventricle, the only means of escape it had left. It has been questioned whether, during the contraction of the ventricles, there is any reflux of blood towards the auricle, or even towards the veins which empty into it: here again opinions are divided.

Now, it may be asked, why contraction simultaneously takes place in the two auricles, and why simultaneously also in the two ventricles? Why does this contraction alternate from the auricles to the ventricles? The median partition, common to the two auricles and ventricles, must render the partial contraction of one of these cavities impossible. The cause of their intermitting will not so easily be accounted for; however, it may readily be conceived, that this action could not possibly be simultaneous, otherwise the auricles could not pour their contents into the ventricles.

The contractions of the heart are similar to those of every other muscle, with this distinction only, that they are involuntary. This contraction, which *Stahl* wanted to assimilate to the voluntary muscular contractions, and was attributed by *Haller* to irritability, is entirely owing to the action of the nerves of the

heart; and these nerves must of course communicate with sound nervous centres, as has been proved by the experiments of *Le Gallois*.

The contraction of the heart is active, but is this organ merely passive in dilatation? Is not this dilatation mechanically produced by the effort of the blood? Nothing similar to it is observable. Dilatation takes place previous to the blood entering this cavity. Tear the heart from a living animal, and it will for some time continue to dilate and contract, although it contains no blood.

In these different motions of circulation, the heart undergoes visible changes. During *systole* its tissue hardens, it becomes shortened, the apex beats against the anterior left part of the thorax, between the sixth and seventh rib. During diastole the phenomena are quite the reverse. These beatings of the heart against the thorax, attributed by several physiologists to an elongation of this organ, evidently proceed from other causes, since, by the very circumstances of such elongation, the valves would be depressed. The beatings of the heart proceed from three causes: 1st. From an oscillatory effect on the base of the organ which is fixed, towards which the whole motion is directed; 2dly, from the auricles in filling with blood, owing to the impossibility of depressing the spine backwards, which propels the heart forwards; 3dly, from the aorta, and the pulmonary artery receiving a strong impulse from the blood transmitted to the heart.

It remains now to be examined how far the influence of the heart extends over circulation. *Harvey* attributes the whole circulatory action to this organ; others say that its power extends no further than the extremities of the arterial system: these questions will come under consideration in the next chapter.

Circulation in Arteries.—Arterial circulation begins in the heart and terminates in the general and pulmonary capillary systems. Two causes preside over this circulation: the one, and undoubtedly the most effectual, is the action of the heart; this action progressively decreases as we approach nearer to the termination of arteries, as is proved by the diminution of the jet in small arteries; this jet is entirely lost in the furthermost extremities of this system. The other cause is the arterial action inherent in the properties of their tissue (*elasticity*), and vital power (*contractility*); elasticity predominates in the larger trunks. This power of circulation, which, it is but true to say, is not secondary, is placed beyond a doubt by a succession of experiments: for instance, if two ligatures be applied to the primitive carotid of a living animal, and a puncture be made between the two ligatures, the blood will jerk out, although the fluid in this instance is no longer influenced by the heart. This phenomenon is not produced by elasticity only. For if the same experiment be repeated after death, the blood will ooze without jet, or at least with a less considerable

one than during life. Thus by the united actions of the powers of the heart and of the arteries, the blood is conveyed to the capillary system. A return of the fluid toward the ventricles is impossible; the sigmoid valves and the afflux of the next supply will not admit of it.

But in its course the blood has many obstacles to overcome; and this accounts for why its progress is not uniform throughout the arteries. The obstacles are: One whole mass has to be moved and increased in some parts in a direction contrary to the order of gravitation; friction, which is increased by the subdivisions, the anastomoses, the curvatures, and the contractions of the arteries. Finally, some allowance should be made for the exertion required to dilate the arterial parietes, when the ventricle imparts a shock to the fluid, already contained within these tubes. This lateral dilatation, which is attended with beating, has received the name of *pulse*. Pulsation presents numerous varieties at the different stages of life, and is influenced by a variety of circumstances to which man is exposed.

Circulation in the Capillary Systems.

Conveyed by the arterial extremities to the capillary systems, the blood, without any interruption to circulation, passesinto the veins; this progress of the fluid is owing to a *special* power in the capillary system, and perhaps also to a continuation of the influence of the

heart and arteries. This latter cause must be very weak, particularly when we consider that a number of animals are unprovided with hearts, that this organ has been deficient, even in the human fœtus, in which subjects capillary circulation existed. Finally, what effect can possibly be expected from so weak a cause as vessels dividing and multiplying to such considerable extent? Thus *Boerhaave* considered that the motion of the heart was completely exhausted at this part of the circle, and referred capillary circulation to the sole action of this system. Since then, Dr. *Wilson Philip* has demonstrated by microscopic observation, that circulation in this system is actually under the immediate influence of the peculiar action of these tubes. But what does this action consist of? Microscopic observation and pathology seem to demonstrate the presence of a kind of vital aspiration in this system, by which the blood is drawn into the substance of our organs. This action submitted to nervous influence, similar to this last, is liable to variation. Capillary circulation may also be assisted by a few physical causes. These causes also may become resistances. Such are gravitation, motions, &c. The resistance in this system, as in the arterial, consists of the mass to be moved; of friction, increased by the subdivisions, and curves taken by capillary tubes. It is generally said, that circulation is slowly effected; but, the rapidity of its course must vary in every

organ, in a proportional ratio with its degree of activity. Finally, it must be modified in the same organ, according to the changes the organ itself may undergo.

It is in the general capillary system that the arterial blood is converted into the venous; and in the pulmonary, that the reverse takes place. This fluid has probably been robbed of some of its principles in the former, in like manner as by its combination with oxygen in the latter, it has borrowed an additional one.

Circulation in the Veins.—Venous circulation is effected from the general capillary system to the right auriele, and from the pulmonary capillary system to the left auriele. The causes of venous cireulation consist in the action of the capillary system, and more particularly in that of the veins, assisted perhaps by some slight influence continued from the arteries and heart. Dr. *Barry*, in a Memoir lately read at the Institute, pretends that the venous blood is drawn into the right auriele by a vaeuum resulting from its dilatation, and by atmospheric pressure.

The motion imparted to the blood by these agents is not very rapid. Thus has nature resorted to a number of meehanical means to surmount the obstaeles opposed to the eourse of this fluid, and to promote its progress. Sueh are pulsations, museular contraetions, the progressive contraction of space in the tubes, through whieh the blood flows, the assistance afforded

by valves, calculated to prevent a reflux of blood, and to divide it into small and more moveable columns; finally, the greater thickness of the superficial venous coats. Moreover, the faculty of dilating, which veins possess, and the extensive capacity of the venous system, are additional means provided against the danger of stagnation. The course of the blood through the veins is uniform and unattended with jerks: it moves less rapidly than in the arterial system, gradually increases as it approaches the heart, whilst the reverse is observed in arterial circulation.

Circulation in the Vena Portæ.—We shall not dismiss venous circulation, without noticing the *abdominal venous circulation.* This system is formed from two distinct trees, which re-unite in one common trunk: the one returning the blood from the digestive organs, the other ramifying in the liver, and distributing to this organ the blood received from the first. We perceive that this fluid, thus transmitted from one tree to the other, crosses two capillary systems—that of the digestive organs, and that of the liver. We must therefore allow that the same powers which circulated it through the vena-portæ, have conveyed it through the liver into the hepatic veins.

Such is circulation, as regards the individual that breathes; but in the fœtus there are important modifications. Here we shall restrict ourselves to the consideration of the state of this function, at the time of

birth; referring to the history of the fœtal functions, and of the changes observable in the different stages of development.

Circulation of the Fœtus.—The essential differences of fœtal circulation at the time of birth from that of the adult, proceed from some remarkable dispositions in the heart, and the vessels. 1st. On the one hand, the umbilical vein proceeding from the placenta, empties itself into the vena-portæ, and on the other, through the venous duct into the inferior vena-cava; 2dly, the partition between the auricles is perforated (*foramen ovale*); 3dly, the right auricle close to the orifice of the inferior vena-cava is provided with a valve (*the eustachian,*) disposed in such a manner as to direct the blood conveyed by this vein, through the foramen ovale; 4thly, The aorta and the pulmonary artery are united by a duct, called *arterial;* 5thly, and finally, the two umbilical arteries proceed from the primitive iliacs to the placenta.

From such a disposition it is evident, that the motion of the blood must be entirely different from that of the adult. According to *Wolf* and *Sabatier,* the following is its course: Absorbed in the placenta by the umbilical vein, this fluid is partly conveyed to the vena-portæ, and partly to the inferior vena-cava, where it mixes with that returned from the inferior parts; from hence it is poured into the right auricle of the heart, and instantly passes through the foramen ovale

into the left, from whence it goes into the corresponding ventricle; and, finally, it is propelled into the aorta and the superior parts. On the other hand, the same as in the adult, the blood is returned by the superior vena-cava to the right auricle, which pours it into the right ventricle, whence it proceeds to the pulmonary artery; by this means the fluid is conveyed partly to the lungs, and partly to the aorta, through the arterial canal, then re-uniting in the aorta descends with that directly returned from the placenta: the mixed fluid is distributed, on the one hand, throughout the inferior half of the fœtus; and, on the other, it is returned to the placenta through the umbilical arteries.

The immediate consequences of this disposition are: 1st. That the two systems communicate by means of the foramen ovale; 2dly, That all the blood is not returned to the placenta; 3dly, That the superior parts receive the best portion of the blood, since it is directly returned from the placenta, where it has been vivified, and it is partly conveyed to the inferior regions, after having circulated through the superior; 4thly, and finally, in the fœtal subject, circulation describes two circles in the figure of 8, re-uniting in the heart.

Bichat and *Magendie* are of opinion, that the blood of the two venæ-cavæ mixes in the right auricle; and that the fluid instantly fills the left, that these two cavities simultaneously contract to propel it into the ven-

tricles, and that, in consequence, they contract, in turn, to distribute blood to all the parts.

At the moment of birth, the foramen ovale, already partly contracted, becomes completely obliterated, and circulation then assumes that character which it presents in the adult.

CHAP. V.

OF ASSIMILATION.

1st. *Composition.*—Now that we have made ourselves acquainted with the function by which the reparative elements are prepared and distributed to all the parts, we are naturally led to that function by which they are assimilated to our organs, and ineessantly renew their substance; for sueh is the object of assimilation.

This funetion, properly speaking, has no peeuliar apparatus. Assimilation is effeeted in all the parts of the body: its seat of aetion is in every organ. It is in their very substanee that assimilation is effeeted, and this substance we should be intimately acquainted with. Its anatomical elements consist of vessels and nerves ramified almost to an infinite degree, in a cellular tissue. But what is the mode of aggregation in these parts? What is their proportion in the different organs? We do not know. We are even ignorant of the manner in which these vessels terminate: injections merely prove that they freely communicate. Some anatomists are of opinion, that the

capillaries of the veins are continuous with those of the arteries; thus they admit of lateral pores, or nutritive exhaling vessels; others pretend, that a spongious tissue is interposed between the capillary extremities of the vessels.

Our information being so very limited with respect to the intimate structure of the organs, the mechanism of assimilation must necessarily be involved in greater obscurity This action, in fact, is only known by its result. Since the time of *Le Gallois,* it has generally been admitted, that the blood is received in the parenchyma of every organ, without having undergone the slightest alteration, and that this fluid is converted into their proper substance.* But we are possessed of no positive fact with respect to the mode of such transformation; and, according to the different ideas which may have been conceived of the termination of arteries, the reparative materials are said to circulate through the nutritive exhalants, or to transude through the pores or spongious tissue of the vessels. But, again, is it by a simple mechanical deposit that the organic particles appropriated to the sensibility of the parts, are assimilated to our organs? Or, does there exist any special elaborating action in the parenchyma? To admit of the former of these opinions

* Some of the ancient physiologists were of opinion, that the blood underwent divers modifications according to the respective organs it was intended for.

would first require that the different organic tissues should be proved by demonstration primitively to exist in the blood, and this is very far from being proved. The supporters of the second hypothesis pretend, that these principles may actually result from a reciprocal action of the elements of the blood, or rather from an elaborating action of the parenchyma: This may possibly be the case with respect to osmazome, cerebral substance, &c.; but what is easily understood, as far as it relates to organic substances, cannot so readily be conceived with respect to metallic bodies, or metalloid elements. Is it not far more probable, that these principles which are known to exist in our food, might be detected in the reparative fluid; but that they float in it in such minute proportions as to baffle demonstration.

Very strange hypotheses have been promulgated with respect to the mechanism of assimilation. For instance, those physiologists who considered the cellular tissue, as the universal element of all the parts, contended that the albumen of the blood, coagulated by the heat of this primitive tissue, and that subsequently this last substance assumed different forms and degrees of density, owing to pressure of the neighbouring arteries, from whence resulted the different organs; chymists would have it that this coagulation was effected by the oxygen of the blood. It would be a waste of time to refute such hypotheses.

It has been generally admitted, that the motion of assimilation is instantaneous in the same manner as that of the blood; but its activity must be influenced by a number of circumstances depending upon a healthy or morbid state, and particularly upon the nature and abundance of the aliment. A medical proverb says, "Good food will make good blood, and good blood a good organization."

2dly. *Decomposition.*—The interstitial absorption of *J. Hunter*, the organic of *Bichat*. The uninterrupted assimilation of new particles to our organs, would soon become productive of monstrous exuberance, had not nature by the most admirable foresight, connected with it a motion of decomposition, which effectually antagonizes the former result. The precise experiments of *Duhamel*, *Baroni*, *Ludwig*, &c. have proved in a most indisputable manner, that the nutrition of our organs is intrusted to the alternation of these two motions. These experimentors caused animals to feed on substances stained red with madder; and, after a certain lapse of time, all the organs, even the bones, were of that colour; having subsequently discontinued this food, the redness was seen gradually to disappear. It was therefore natural to conclude, that the animal economy is in turn composed and decomposed in an uninterrupted circle as it were.

The mechanism of this decomposition has been described in speaking of absorptions; we have seen in

what deep obscurity this function is involved. In all probability, both venous and lymphatic absorptions, simultaneously concur in its production; and it is generally allowed, that the particles newly admitted are the last to be re-absorbed.

From the harmonious alteration of these two phenomena, results a continuous molecular renovation of our organs, in virtue of which, at length, the whole economy has undergone an entire change. According to the ingenious simile of *Richerand,* the animal machine resembles the ship of *Theseus,* which had so repeatedly been repaired during the voyage, that not a single nail of its primitive construction was left on its return into port.

The time required for this entire renovation has been estimated with respect to man, by the ancients, at seven years; but most probably this must vary with every individual, according to the degree of energy of nutrition, and with every organ, in proportion to its degree of vitality; so that it is actually impossible to lay down a general rule.

CHAP. VI.

OF CALORIFICATION.

The *Blood* is not only intended for the nutrition of our organs, but by entering into their substance, it also keeps up their temperature in a permanent degree, let the circumambient heat be what it may. Thus, *Tillet* and *Duhamel* have seen a young girl bear, for the spaee of ten minutes, 112 degrees of heat, without her own caloric having undergone the slightest change. *Banks, Solander, Fordyce, Berger,* &c. have themselves withstood 79 degrees of heat in vapour baths, without experiencing any inconvenience.

Dr. *Edwards* has remarked, that the temperature of the human body presents some differenees as regards age, sex, temperament, health, or a morbid state, &c. He has observed this temperature to rise to 34,35 *th. cent.* with infants; from 35 to 36 in subjects sixty years of age; and from 34 to 35 with octogeneranians.

Source of Caloric.—The ancients plaeed it in the heart; *Descartes* admitted of ebullition in this organ;

Vanhelmont of an effervescense; *Vicussens* of fermentation; *Borelli* pretended, that an ignited spirit was disengaged by the motion of the heart, &c.

At the time of the discovery of the chemical theory of respiration, the combustion of carbon was considered as the essential source of caloric. To ascertain this, *Lavoisier* and *Laplace* confined animals under a calorimeter, and comparing the quantity of carbonic acid formed, with the quantity of heat produced within a given time, they found that the caloric disengaged was equal to that necessarily required for the quantity of acid formed. *Crawford* added, that the arterial blood by the great capacity it afforded for caloric, gradually absorbed this fluid as it became disengaged by combution, and consequently acquired a degree of heat superior to that of venous blood. If to these considerations we add, that heat in the animal scale is so much the more intense, as respiration is more extended, that animals bear the privation of air, so much the less as their temperature is higher; finally, that heat lowers in proportion as respiration slackens, as has been observed by *Le Gallois*, *Thillaye*, and *Brodie*: we shall naturally be led to conclude, that respiration, properly called, is, if not the only cause of caloric, at least one of its principal sources.

Chaussier, has made caloric one of the primitive vital properties. *Adelon* says, that the lungs are no further subservient to calorification, than by absorbing

ambient heat. Others pretend that caloric is only disengaged by the approach of blood in the substance of the organs. *Boin* considers it as a result of the action of all the vital functions. In fact, digestion, running, &c. are seen to increase animal heat; but does not this proceed from circulation being more active, and consequently from the blood being more frequently brought in contact with atmospheric air?

Finally, *Brodie* and *Chaussat*, by experiments, which consisted in decapitation, consequently in the destruction of nervous centralization, and keeping up respiration by inflating the lungs, have seen heat gradually sink, which indispensably proves that the nervous apparatus is also a focus of heat; but this is not the only one, as these authors have supposed. The part which respiration acts in the production of animal heat is established by undeniable arguments.

Finally, the lungs and the nervous centres are the organs of calorification. With respect to the mode in which caloric is propagated, it is evident, that, on the one hand, it is distributed by arterial blood to all the parts, since this fluid is loaded with it; and on the other hand, that, proceeding from the nervous system is probably transmitted to the organs, through the intermedium of the nerves.

Davy and *Edwards* pretend that each organ is possessed of a degree of heat proper to itself. It would be interesting to know, whether the differences that have

been remarked in the different parts in this respect, are in a manner connected with the number of vessels and nerves which these parts receive. Generally speaking, parts are colder, as they are more distant from the caloric foci.

Causes tending to modify Animal Heat.

1st. *Artificial Heat.*—Man, as we have already seen, can withstand degrees of temperature far superior to his own, and this in consequence of the following reasons: 1st. The skin is not a good conductor of caloric, consequently it absorbs but little. 2dly. *Franklin* has demonstrated, that the principal reason is the evaporation of cutaneous and pulmonary perspiration, and that in this respect the body might be compared to an *alcarazas.* This assertion has subsequently been substantiated by *Delaroche*, who, placing animals in steam-baths, loaded with vapour, in which consequently evaporation was impossible, has seen them sink under a degree of heat little superior to their own.

Death is the consequence when the temperature of the body rises from five to six degrees.

2dly. *Cold.*—Man sustains cold better than heat; he supplies either by his own means, or artificially, the loss of caloric which his body incessantly undergoes. In the first place, his own calorific action increases in

energy; and this accounts for why the chest of the northern inhabitants is generally more developed. 2dly. The skin being a bad conductor of caloric, it follows, that little is exhaled from it. 3dly. Man prevents too great a loss by cloathing and fire. 4thly, and finally. He makes up for losses by aliment and exercise.

Ultimately, however, when these means can no longer suffice, the subtraction is too rapid and too considerable. Then the temperature falls to twenty-six-degrees, and the subject sinks. In this case death supervenes, according to *Chaussat*, from the exhaustion of the nervous powers, an opinion which, as will be easily perceived, follows as a consequence of his theory of animal heat.

CHAP. VII.

OF SECRETIONS.

By secretion is understood, that function by which certain organs form, with the blood they receive, new humours, intended in our economy, for different uses.

Each secretory system includes in its organization, vessels which convey the material for secretion, and a particular order of tubes through which the secreted fluid is carried away. It is generally admitted, that these two systems, which ramify ad infinitum, unite at their extremities. We distinguish three species of secretory organs; the *exhalants*, the *follicles*, and the *glands*. We shall study secretion in this order.

ARTICLE I.

The exhaling secretory organs, are the most simple in our economy, they consist of spongious forms, or of membranes, and their whole organization appears to be reduced to capillary vessels, which, at the moment

they exhale, or suffer the secreted fluid to escape, assume the name of exhalants or of excretories.

1st. *Serous Exhalation.*—This name is given to a kind of albuminous fluid, which collects on the internal surface of the serous membranes, such are the *arachnoid pleuræ, pericardium, peritoneum,* and *tunica-vaginalis;* they form thin, cellular transparent membranes in the form of imperforated sacs, lining the splanchnic cavities, and reflected ovèr the organs contained therein. Their internal surface is constantly moistened by a kind of transudation, the product of which, according to *Beclard,* is a gelatinous mucus, similar to that met with in the albumen of the blood. This humour is taken up by internal absorption, as it is gradually exhaled ; formerly this secretion was attributed to small glands. *Ruysch* has proved that no such glands exist. Serous exhalation, which habitually takes place in the spongy substance of the cellular tissue, should rank in the first class of secretions.

As much may be said with respect to the secretion of *synovia.* The membranes, at the surface of which this secretion takes place, are similar in structure to the serous membranes; they also form imperforated sacs, which line the articulations, and the tendinous sheaths, and are sometimes met with under the skin, on a level with osseous projections; the product is viscous, transparent, and rather of a saline flavour. Its chemical composition is as follows: water

albumen, fibrin, soda, muriate of soda, and phosphate of lime, formerly the secretion of synovia, was attributed to the cellulo-vascular granulations found in articulations. *Haller* took it for the medullary juice, which he supposed to transude through the extremities of the bones; such also was the opinion of *Desault*, until *Bichat* demonstrated the real source of synovia.

Finally, it is also to serous exhalation that the formation of the aqueous, chrystalline, and vitreous humours of the eye, are referred, as well as the perspiration said to exist in the interior of vessels.

2dly. *Cutaneous Exhalation.*—The skin, as well as the preceding membranes, contains in its structure an infinite number of capillary vessels, which open on its surface, under the denomination of exhalants; through these vessels, there incessantly escapes an albuminous vapour, which is instantly evaporated by air, or absorbed by the clothes: transpiration in this case is called *insensible*; or again, this vapour being more abundant, shews itself in the form of drops, trickling on the surface of the skin, and in this case it assumes the name of *sweat*.

This fluid is limpid, contains a large proportion of water, a trace of acetic or lactic acid, muriate of soda and of potash, a little gelatine, phosphate of lime, and oxide of iron; cutaneous transpiration is very abundant, and is, according to *Sanctorius's* experiments, the most abundant of fluids; several attempts

have been made to determine its proportions, but the results have considerably varied; and this might have been easily foreseen, on reflecting that the temperature, the dryness, the humidity, and the agitation of the atmospheric, are so many causes, by which cutaneous secretion, must be influènced, which secretion besides must also vary according to idiosyncrasies.

The mucous membranes (the organization of which differs from that of the skin) are also the seat of transpiration, particularly obvious in the aerial tubes. The latter, according to the experiments of *Lavoisier* and *Seguin*, yield two pounds fifteen ounces of liquid a day, whilst cutaneous perspiration gives an ounce less. The product of pulmonary transpiration is a mixture of sero-albuminous vapours and carbonic acid, some physiologists attribute it to a combination of the hydrogen of the venous blood, with the oxygen of air.

The exhalation of the humour of Cotunnius in the internal ear may rank with the mucous transpiration.

3dly. *Adipose Exhalation.*—The adipose tissue (a long time confounded with the cellular) consists of minute membranous vesicles, which receive their vessels through a small pedicle, by the means of which they cluster together, somewhat in the form of a bunch of grapes; it is in their interior that the exhalation of fat takes place. Adeps is a yellowish coagulable matter, almost insipid, and composed, according to

Chevreuil, of *elaine* and *stearine*. The exhalation of this substanee is as simple as the preceding. *Haller* contended that this matter was ready formed in the blood. Lately, *Chevreuil* has substantiated this assertion by demonstration. Fat acts as a eushion, as it were, to ease the motions of the neighbouring parts, but moreover, it may be eonsidered as an aliment that nature keeps in store.

In the eentral canal of long bones, in the spongious substanee of their extremities, and of short bones, as well as in the pores of the compaet substance, we meet with vesicles nearly similar to the preceding, which also are the seat of an exhalation of juiee, known under the denomination of *marrow*, in the medullary canal, and under that of *medullary* or *oily juice*, in the spongy and compaet substanees of the bones. The ehemical composition of this matter is analogous to that of fat, with this exception only, that it is moie fluid, which in all probability is owing to its eontaining a larger proportion of *elaine*.

4thly. Finally, we rank in the last order, the seeretions of the colouring humours of the skin, the pigmentum of the ehoroïd of the iris, verging upon black, and of the ciliary proeesses; lastly, those albuminous humours met with in the eapsulæ renales, the thymus, and the thyroïd gland, &c.; their exhalation is sufficiently elucidated by what has preceded.

ARTICLE II.

Follicular Secretions.

Follicles are secretory organs of a more complicated nature, and less generally distributed than the preceding; they consist of small vesicles, situated in the substance of the skin, and of the mucous membranes, at the surfaces of which they open by a small contracted neck. We are very imperfectly acquainted with their organization, and we merely know that it is vascular to an excessive degree, and that the vascular system communicates with the excretory ducts, as is proved by injections. These follicles are isolated, simple or compound, and according to the nature of the humour they secrete, they are divided into *sebaceous*, or *mucous*.

1st. *Sebaceous Secretion.*—The cryptæ of the skin, habitually secrete an oleo-albuminous humour, which lubricates the whole surface of the body, and keeps up its suppleness, constituting at the same time an actual loss in the economy; this fluid is very abundant, and it is of rather an offensive smell, in the auditory duct, in the axilla, and at the genital parts, &c.

2dly. *Mucous Secretion.*—The mechanism of this secretion is the same as the preceding, its produce is *mucus*. Its nature, and particularly its quantity vary

in every mucous membrane; this fluid is generally white, viscous, insipid, incoagulable by heat, insoluble in alcohol, soluble in acids. To this secretion we refer the humour of the carunculæ lachrymales, of the labial glands, of the tonsils, of the prostrate glands, and of the follicles of Cowper, &c.

ARTICLE III.

Glandular Secretions.

The glands are the most complicated secretory organs in the economy; they are distinct from every other part, their organization is remarkably complex, difficult to unravel, and for that reason has received the name of *parenchyma*. Their structure consists of—1st. Arteries, by which the materials of nutrition and of secretion are conveyed; 2dly, Of excretory vessels, which retake and reject the secreted produce; of veins, and lymphatics; 3dly, Of nerves; 4thly, Of cellular substance, reuniting the capillary extremities of all these parts, which molded into globules, are subsequently conglomerated together to constitute glands. *Ruysch* is of opinion, that the vessels which bring the materials for secretion, are immediately continuous with those through which secreted humour is removed. *Malpighi* and *Richerand* admit of follicles being interposed between these organs.

1st. *Secretion of Tears.*

Organs.—The lachrymal apparatus is composed on each side:—1st. Of a small amygdaliform gland, situated at the external and anterior part of the orbit; 2dly, Of six or seven excretory ducts, which open inwards at the superior eyelid; 3dly, Of two lachrymal ducts, extending to the free edge of the eye-lids close to the internal angle of the eye, terminating by two projecting orifices, verging upon black, called the lachrymal points; 4thly, Of a small reservoir in the the os-unguis and the super-maxillary apophysis in which the above-mentioned ducts are continued; 5thly, Finally, of the nasal canal, continuous with the lachrymal sac, and opens into the inferior meatus of the fossa nasalis.

Functions.—The ancients placed thes source of tears in the caruncula lachrymalis, some thought that they transuded through the cornea; *Haller* attributed their exhalation to the lachrymal gland, and conjunctiva. This fluid is incessantly poured over the globe of the eye, by the small excretory ducts of the glands, to moisten it, and keep up its transparency, facilitating at the same time its motions; it is subsequently reabsorbed by the lachrymal puncta, and conveyed to the fossa nasalis, where it is mixed with the mucus. Upon analysis, this fluid is found to contain a great proportion of water, mucilage, phosphate of soda and of lime, with muriate of soda.

2. *Secretion of Saliva.*

Organs.—The salivary glands are three in number, at each side of the mouth:—1st. The *parotid*, situated posteriorly to the jaw, its excretory canal (*the canal of Stenon*) opens in the mouth near the second small molar tooth; 2dly. The *sub-maxillary*, placed below the base of the jaw, *the canal of Warton*, which forms its excretory duct, opens in the mouth, close to the frœnum of the tongue; 3dly, and finally, The *sublingual*, provided with several canals, which open in the vicinity of the former.

Functions.—These glands constantly pour into the mouth a viscous insipid humour, which soon mixes with the air, and becomes frothy. It contains a good deal of water, some animal mucilage, lactate of soda, muriate of potash, and of soda, &c.

Secretion of Pancreatic Juice.

Organ.—The pancreas is a gland which bears the utmost analogy with the preceding; situated transversely behind the stomach. It rests upon the spine, it is provided with an excretory canal, which opens into the duodenum, at the re-union of the two superior thirds, with the inferior.

Function.—The fluid secreted by this gland, flows according to some authors (*Magendie*) in a continuous manner into the duodenum, according to others, dur-

ing digestion only. It appears, at least, that at this time the supply is most abundant. We are but imperfectly acquainted with the nature of this fluid. It is generally compared with saliva. *Hoffman, Boerhaave,* and *Magendie,* call it alkaline; others, acid.

4th. *Secretion of Bile.*

Organ.—The liver is the largest gland in the animal economy, situated in the abdomen below the diaphragm, above the stomach and the intestines; this organ fills up the right hypochondriac region, and a portion of the epigastric. Its form is not easily described; one of its surfaces is convex, directed upwards and forwards, the other concave, and placed downwards. From the latter, which is remarkably irregular, the common trunk of the excretory vessels is sent off; this canal running downward and inward, soon meets the duct of the gall bladder, with which it unites at an acute angle, to form the ductus choledochus; subsequently it opens into the duodenum in common with the pancreatic duct.

The organization of the liver is that of glands in general; but what essentially distinguishes it from others, is, that it receives a large quantity of venous blood, conveyed from the digestive organs, and the spleen, by the vena-portæ.

Function.—When the blood has reached the furthermost ramusculæ of the vascular system of the liver, it is submitted to an elaboration in these tubes, and

converted into bile; from that moment this new produce flows slowly into the excretory canals, from the circumstance of secretion being continual, assisted also, no doubt, by the habitual motion of the neighbouring parts; during this course the most fluid parts are absorbed, and bile consequently gradually concentrates until it reaches the duodenum.

Some physiologists pretend that the bile uninterruptedly flows into the intestine, but that out of the line of digestion a part is returned to the gall-bladder through the cystic canal, to be thickened, concentrated, and subsequently evacuated, when chylification requires its assistance. *Magendie*, in his experiments, has actually seen bile flow, without distinction of time, into the duodenum; but other authors, arguing from the difficulty a part of the bile must experience in returning into the cystic duct, (the ductus choledochus remaining open,) maintain that the latter is contracted excepting at the time of digestion, and that for this reason bile is forced back into the gall-bladder. The nature of this work will not admit of controversies, I shall merely restrict myself to saying, that nothing leads us to admit of a permanent contraction of the ductus choledochus when digestion is not going on, and that the first opinion, which is the most generally received, appears to me the most conformable to truth.*

* Formerly, physiologists admitted of *hepato-cystic* canals, through which the bile was supposed to be propelled into the gall-bladder.

Bile is a viscous bitter fluid, more or less of a deep yellow green colour; that which has remained for some time in the gall-bladder, is much thicker and better formed. This is the kind of bile that is chosen as a type for its physical and chemical properties, it contains a large proportion of water, of albumen, a resinous matter, a yellow colouring substance, soda, hydrochlorate, and sulphate of lime, phosphate of lime, and oxide of iron. *Chevalier* found picromel in it, *Chenard* and *Orfila* affirm it contains none.

Divers hypotheses have been advanced with respect to the source of bile: some would have it to originate from the vena-portæ, others from the hepatic artery; finally, some entertain a mixed opinion. The first argue the existence of the vena-portæ; 2dly, the nature of the blood containing more hydrogen and more carbon, and for this reason more likely to produce a fatty substance, such as bile; 3dly, the calibre of the vein, which appears better connected with the abundance of the secretion than that of the artery, which is merely intended seemingly for the nutrition of the organ; 4thly, the communication of this vena-portæ with the excretory ducts. The authors of this opinion consider the spleen as a vascular ganglion, commissioned to prepare the materials of bile.

Physiologists, on the contrary, who considered the bile to proceed from the arterial blood, grounded them-

selves on, 1st. the analogy with the other secretory glands, 2dly, the absence of a vena portæ system in invertebrated animals; 3dly, cases in which this vein is seen to open into the vena-cava; adding that this vena-portæ is much developed in the fœtus, and that in this subject the secretion of bile is almost void; and that the arterial blood besides is very likely to produce fat substances, since it contains the source of adipose exhalation, &c. But in this case what purpose is the spleen intended for? Here imagination is under no restraint and hypotheses crowd in from every direction. *Chaussier* says, the spleen exhales a juice that occurs in preparing the lymph. *Tiedmann* and *Gmelin* are of opinion, that it separates a fluid proper to animalise the chyle. Others pretend that this organ prepares the blood for the secretion of the gastric juice. *Lieutand* and latterly *Broussais*, consider the spleen as a diverticulum for the circulation of the blood of the stomach. The latter author even extended this use to the vena-portæ with respect to the intestinal canal. Thus in the present state of science the source of bile is still a question; it would require direct experiments to resolve it, for on so delicate a subject reasonings unavoidably are more or less specious, and can never afford grounds for demonstration.

Bile is an indispensable humour for chylification; a redundant secretion of which stamps the economy with a peculiar character, which constitutes a temperament.

5th. *Secretion of Urine.*

Organs.—The urinary apparatus is the most complex of the secretory apparatus. It is composed of—1st. *The kidneys.* These organs are two beanlike glands, situate in the abdomen on the sides of the spine, in front of the last false ribs, and of the quadratus lumborum muscle; they are enveloped on all sides with cellular tissue, loaded with fat; their volume is small comparatively to the abundance of their secretion; but they receive a very large artery, which may convey to these organs about the eighth part of the blood of the aorta. Their parenchyma consists of a cortical or glandular substance, forming the external part, two or three lines in thickness; finally of an internal tubular or fibrous substance; this is composed of a collection of pyramidal excretory capillary ducts (*ducts of Bellini*), which empty into the pelvis, forming small mammillary processes received into the calyces or infundibula.

2dly. *Of the Ureters.*—The ureters are two excretory canals of the thickness of a common quill, they originate in the substance of the kidney through an oval cavity called the pelvis, resulting from a reunion of all the calyces; this cavity contracts into an infundibulum to form the ureter, properly so called, which empties into the lower part of the bladder.

Of the Bladder.—The bladder is a muscular-mem-

branous reservoir, situated in the cavity of the pelvis, before the rectum or the uterus, and which may be considered as a common dilatation of the two ureters, which open into the inferior part of this reservoir; the excretory orifice or neck, is situated somewhat above the bottom and anteriorly; it is provided with a fleshy tubercle called the *luette vesicale*; at first it is rather expanded, but soon contracts to form the urethra. The parietes of the bladder are formed, *internally*, of a mucous membrane; outwardly, of a fleshy membrane, whose longitudinal or oblique fibres frequently anastomosing seem to proceed from the neck, where they are transverse and more compact, and form the *sphincter of the bladder*. Lastly, the peritoneum forms a third membrane, but it only lines the posterior part of the organ.

4thly. *Of the Urethra.*—This canal forms the last part of the urinary apparatus, and the excretory duct of the bladder, extending in man from the neck of the organ to the end of the penis; it terminates in the female immediately below the symphisis of the pubis, so that its length essentially differs in the two sexes. This canal consists of a mucous membrane, covered externally, with spongious cellular tissue, remarkably vascular. In man we distinguish three parts: the first, an inch and a quarter or an inch and a half in length, crosses the prostate gland: slightly scooped in its centre it presents a kind of longitudinal ridge, called

verumontanum; and the orifices of *Cowper's* glands, of the prostrate, and of the ejaculating canals; the second portion about an inch long is surrounded by no organ, and for this reason is called the *membranous portion*: finally, the third, supposed to measure six inches, is encompassed by erectile tissue, and assumes the name of *spongious portion*, it forms a part of the penis.

Function.—1st. We are not better acquainted with the mechanism of urinary secretion than with that of the preceding secretion. The kidney is evidently the secretory organ. *Galen*, to demonstrate this fact, repeatedly tied the ureters in living animals, and in every instance he saw the urine accumulate above the ligature, and the bladder remain empty. It is generally supposed that the secretion of urine takes place in the cortical substance, it is in this substance, in fact, that all the emulgent vessels open and ramify to a great extent; their communications are innumerable, and even so far so, that injections freely pass from the one into the other, and often make their way into the excretory extremities.

From this glandular substance, the urine passes directly into the tubular ducts of *Bellini*; subsequently it drops from the tip of the papillæ into the calyces, from whence it flows into the pelvis, and hence into the ureter, by which the fluid is transmitted to the bladder. Urine undergoes some modifications in the long course it runs, influenced by its own specific

gravity, by the continuity of the secretion, as well as by the contractility of the tubes, and the motion dependant upon respiration, it clarifies as it were; whitish and thick as it flows from the kidneys, it becomes limpid, or assumes a light citron colour, as it gradually draws nearer to its proper reservoir.

2dly. *Accumulation in the Bladder.*—Urine accumulates in the bladder, and gradually distends it; and notwithstanding that pressure is effected in every direction, this organ chiefly fills from below upwards. The lower portion presses against the rectum in man, against the vagina in the female. At the upper portion it rises above the pubes, draws and raises the peritoneum; when distention is considerable, it is seen to reach even the umbilicus.

It has been questioned how urine could effect sufficient pressure to accumulate in such considerable quantity. It was formerly thought that this liquid was influenced by the laws of fluids, the pressure of which is in a proportional ratio to the height of the column multiplied by its base; but this observation falls to the ground, when we reflect that urine does not form an uninterrupted stream in the ureter, and if we consider that the ureters take a very oblique course in the parietes of the bladder, it will be better understood that these canals must be the more flattened and compressed as the accumulation becomes more considerable, and that consequently a reflux is next to an impos-

sibility. On the other hand, the contraction of the sphincter of the neck, the angle the ureter forms with the bladder, in common with the natural contraction of the parieties of that canal, which are pressed from below upwards by the anterior fibres of the elevator-ani, are additional causes, which must prevent an escape of urine.

The space of time in which urine remains in the bladder varies:—1st. In consequence of its quality and nature; 2dly. According to ages and sexes; 3dly. According to the healthy or morbid state of the excretory organs. This detention of urine in the bladder is evidently calculated to free us from the disgusting necessity of continually passing the excreted fluid.

3dly. *Excretion.*—Subsequently to its having remained for some time in the bladder, urine is concentrated, its most fluid parts are absorbed, at the same time it becomes more exciting, stimulates the bladder, and creates a particular want, perfectly distinct by its design—the want of *passing water.* It constitutes one of the special internal sensations, which are attended with pain or pleasure, accordingly as they are resisted or indulged.

Warned by this sensation, the diaphragm and the abdominal muscles simultaneously contract to effect pressure on the bladder, and rouse it to action; at the very moment the organ contracts, the sphincter, the levatores ani, and bulbo-cavernous, become relaxed. Urine, compressed on all sides, overcomes the resist-

ance afforded by the neck, crosses the whole extent of the urethra, and is projected at a greater distanee, in proportion as the contractions may have been more foreible; the jet is aecelerated by the action of the parietes of the excretory eanal, and of the bulbo-cavernous muscles. Generally, as soon as the fluid has overcome the obstacles, the associated muscles relax, and nothing more is left than the eontraetion of the bladder, to continue the exeretion; finally, to expel the last drops of urine, the levator-ani muscles contraet to raise the inferior part of the bladder above the neek, and thus aceommodate the fluid with an inelined plane. Subsequently to the exeretion, the bladder re-assumes its primitive state, and sinks behind the pubes.

I have said, that the action of the bladder is solicited by the pressure afforded by the abdominal muscles, this is, in faet, what generally oeeurs, but I have not pretended to say, that this action is independent of the will, it is evident we may use this faeulty at discretion, without the slightest assistance from the above-mentioned auxillary muscles; paralysis of the bladder aetually demonstrates that these accessories would prove insuffieient for urinary exeretion.

Struek with the rapidity with whieh fluids admitted into the stomach are expelled under the shape of urine, the aneients would have it, that there was a direct communieation from the stomach to the blad-

der: *Chirac* pretended to have seen this reservoir fill with urine subsequent to the ligature of the ureters, which is more than doubtful; on the other hand, *Darwin*, made one of his friends take some nitrate of potash, and retraced this salt in the urine, without discovering the slightest atom of it in the blood. *Brande* made a similar observation with respect to *hydrocianate* of potassium. But recently, *Fodere* repeating the experiment of *Brande*, has been more successful; he retraced the salt, both in the urine and in the blood: This particular communication for urine therefore does not exist.

Haller had imagined, that fluids, previously to their being converted into urine, had to travel through the long course of the lymphatics; but he accounted for the rapidity of urinary excretion, by stating that one hundred ounces of blood were conveyed to the kidneys in the course of an hour, and supposing this blood contained only a tenth part of urine, there resulted a secretion of one hundred ounces seven pounds, and a quarter per hour.

Magendie, is of opinion, that the veins absorb the fluids, and immediately transmit them to the arteries, whence results the rapidity of urinary secretion.

Finally, other physiologists pretend, that urine which is evacuated soon after the taking of fluids, is owing to a distension of the stomach, that presses the abdominal viscera down upon the bladder; but this, by no

means explains why the quantity of urine is increased.

Urine, considered in itself, is a transparent fluid, varying in colour, from a slight yellow to a deep orange, of a saline flavour somewhat pungent, of a particular odour, which becomes ammoniacal by the contact of air; of a greater specific gravity than water, staining red the tincture of litmus. It contains, according io *Berzelius*, water, urea, sulphate of potash and soda, phosphate of soda and ammonia, hydrochlorate of soda and ammonia, lactic acid, acetate of ammonia, some animal matter soluble in alcohol, some insoluble, earthy phosphate with a trace of lime, uric acid, silicium, and mucus proceeding from the bladder.

We distinguish three sorts of urine: 1st. The *urine* proceeding from beverages; a clear, transparent, and almost colourless fluid; 2dly, that proceeding from chyle, voided three or four hours after meals; 3dly, and finally, the *urine* from the blood; passed at rising in the morning, it is the best formed, and is taken as a standard for the physical and chemical properties.

Urinary secretion, the same as all other secretions, tends to purify the blood and on the same account tends to decomposition; it takes from the reparation and nutritive fluid the exhausted materials, or that too remote from our nature to become assimilated; urine, the ancients said, was a kind of suds, intended to wash away the impurities in the animal economy.

ARTICLE IV.

Mechanism of Secretions in General.

Arterial and venous blood have been seen to be conveyed to every secretory organ. These organs have been found to return a new product; but how has this wonderful change been effected? On the one hand, it appears that the blood retains all its properties throughout the whole of the vascular system; on the other hand, we find the secreted fluid, the very last and minute ramusculæ of the excretory vessels. It is evidently, then, at the re-union of these two different orders of vessels that the secretion takes place. But in virtue of what power?

1st. *Physical Theories.*—The decrease of vessels proportionally with the divers vascular globules, in common with the idea, that, every humour primitively existed in the blood, has led to the consideration of the various secretions, being so many mechanical filtrations. In fact, it is nearly in this light that they were considered by *Boerhaave*, *Malpighi*, *Haller*, &c.

Hamberger professes that humours are deposited in their respective secretory organs, by reason of their specific gravity. Others compare the secreting vessels to wicks of cotton, which have retained from a mix-

ture of fluids, that only, which they had primitively imbibed.

In modern times, *Fodere* has been led by a numerous series of experiments to consider exhalation as a mere transudation, and absorption as a kind of imbibition; and to conclude that these two phenomena are entirely dependant upon the capillarity of the tissues. He asks, whether it would not be proper to extend this idea to follicular and glandular secretions? But here he prudently stops, preferring to remain in philosophic doubt.

It is evident that every one of these physical theories, with respect to secretions, rest upon a single and similar foundation; each in fact supposes the humours to exist primitively, ready formed in the blood, and this proposition comes next to a demonstration in the following experiments: *Dumas* and *Prevot* have found urea in the blood of animals, subsequently to the extirpation of the kidneys; they have found this fluid to contain sugar and milk, subsequently also to the amputation of the breasts. Finally, they have obtained artificial fœcundation by using blood of toads after the animals had been castrated. It is well known, besides, that in Paris, *Chevreuil* has detected fat in the blood, and that the experiments of *Dumas* and *Prevost*, with respect to the extirpation of the kidneys, have met with complete success when repeated by *M. Segalas.*

Chemical Theories.—Some physiological authors

amongst the ancients admitted of a particular fermentation in our secretory organs, by virtue of which the blood is converted into a new fluid. *Berzelius* explains secretions by electric influence. *Prevost* and *Dumas* pretend, that the secreted humours are the result of a galvanic power, produced by the globules of the blood, which they represent as so many galvanic pairs. The observations of *Fodere*, who has seen transudations rendered active by an electric current, seem rather to substantiate this opinion.

Vital Theory.—Dissatisfied with the preceeding hypotheses, the greater number of modern physiologists consider secretions as an action proper to the secretory organs, by which the blood is elaborated in a special manner, and is converted into a new fluid. This opinion is traced as far back as *Bordeu*, who viewed in each organ a kind of digestive action; but the nature of this peculiar organic and vital elaboration is unknown, so that it does not at all elucidate the question. It is however a subtle explanation, tending to stifle further researches, which the science stands so much in need of, to unveil the real mechanism of these functions.

CHAP. VIII.

INFLUENCE OF THE NERVOUS SYSTEM OVER THE ORGANIC FUNCTIONS.

We shall study in a special manner the nervous system, in treating of the functions of relation. But I consider it proper, to enter previously into a few considerations with reference to the influence this system has over the functions we have just been considering.

Nerves, in fact, spread their influence over all organic functions, and that special influence or power, perfectly distinct from every other nervous action, has received the name of *innervation*. Is it not by this influence being suspended, that we have seen the functions of respiration and digestion destroyed in the section of the pneumo-gastric nerves? Is it not by the same cause that *Le Gallois* suspended the action of the heart in his most interesting experiments on the spinal

marrow? Is it not by an interruption of this influence that *Beclard* has checked some secretions by separating the nerves from the instruments of the secretions? Is it not by the same cause that *Brodie* and *Chosat* have extinguished calorification? And, finally, is it not owing to nervous influence being interrupted, that *Dupuy, Dupuytren,* and *Breschet,* have destroyed horses, by extirpating the nervous ganglia of the neck.

But does *innervation* indistinctly extend its influence over every organic function? Or is this influence restricted to a few only? Some physiologists pretend,it gradually lessens with the inferior functions, and completely disappears in absorption and assimilation; and they chiefly argue from the nutrition of vegetables. But, in the first place, this analogy is incorrect: next, Is it actually demonstrated that the nervous system is entirely wanting in that class of organized beings? On the contrary, we have said, that *Haller, Linneus,* and *Brachet,* considered as such, the central marrow and its diverging rays, and that *Dutrochet* had discovered real nervous ganglia in several plants.

Most modern physiologists, on the contrary, are of opinion, that *innervation* presides over every organic function; only they add, that gradually as we immerge into the deeper acts, its influence becomes the more and more independant of the nervous centres. According to them, the nervous system is the first wheel in the machinery; it is the providing and conducting

agent of the vital principle; it even pre-exists organization, according to *Dumas* and *Prevost*, who have traced its rudiments in the spermatic animalculæ.

Which are the nerves commissioned to distribute *innervation*? In this respect authors do not agree. Some pretend that every nerve equally concurs to it; others, *Bichat, Reil, Gall, Brousais*, &c. assert, (and, in my opinion, are better grounded,) that this important function is the attribute of the par-vagum, and of the grand sympathetic. In the first place, the former is a cerebral nerve; it animates the three most important organic functions, namely, digestion, respiration, and circulation; it is from this nerve their pre-eminence is derived. On the other hand, the grand sympathetic penetrates with the vessels into the parenchyma of every organ, and is perfectly distinct from every other nerve, so far that we have found it nearly insensible to every kind of stimulus. And this actually is the character of most part of our organic functions, to which this nerve is specially distributed. They take place passively, as it were, unconscious to us, and without the slightest perception being conveyed. On the other hand, according to *Ackermann*, this is the first nerve developed in the fœtus, we meet with it in every animal provided with a brain, it actually then is in a direct manner subservient to negative life. According to *Beclard*, the ganglia of this nerve are intended

to check the influence of the nervous centres over the organs of organic function, and to prevent the transmission of their impressions, so that they separate the vegetative functions from those of relation. They also concentrate the nervous power, which they either develop or borrow from the spinal marrow, to distribute it subsequently to the organs they hold in dependance.

Thus, organic nervous influx originates, on the one hand, from the brain, by the pneumo-gastric nerves; and, on the other, from the splanchnic ganglia, which probably also borrow from the spinal marrow. What does this nervous influx consist of? is a question we are unable to answer; and here again we must plead ignorance. Numerous facts concur to establish its analogy with the galvanic fluid. 1st. *Wilson* has restored digestion, calorification and secretions, subsequent to the section of the nerves, by a galvanic current. 2dly. The nervous fluid itself developes the galvanic:—thus *Aldini* has produced muscular contractions by causing the nerve to communicate with the muscle, through the means of a metallic curved conductor. *Humboldt* has even remarked, that the conductor being placed at a line distant from the muscle, was sufficient without contact to make the latter contract. 3dly. On dividing the nerves to destroy the nervous influx, that influx will continue to be propagated if the two ends are not sufficiently distanced from each other; and this

undoubtedly through *influence,* as we find to be the case with respect to the electric fluid? Next come the experiments tried by *Prevot* and *Dumas,* having muscular contractility in view, which they represent as an electric phenomenon.

FIRST CLASS.

ORDER THE SECOND.

FUNCTIONS OF RELATION.

THE functions of relation render man conscious of his own existence ; they consist of those which establish between him and the whole universe suitable connections for his preservation. They are four in number. The function of sensations, that of intellectual and moral acts, that of voluntary motions, and that of expressions.

CHAP. I.

OF SENSATIONS.

ARTICLE I.

Of Sensations in General.

To sensations we are indebted for a knowledge of ourselves; sensations also warn us of the positive existence of surrounding objects; sensations likewise preside over self-preservation, by inducing us to avoid danger, and warning us of the wants of our economy; by sensations man is induced to lead a social life: sensations, in short, solicit the connection between the two sexes, and consequently preside over procreation.

Sensations are developed under the influence of any irritation. But, at times, this irritation results from the application over our surface, of external bodies, or from particles arising from them; at others,

on the contrary, they proceed from some internal modification the deeply situated organs undergo, whence is derived the proper distinction of *internal* and *external* sensations.

If there be a difference in the source from whence the impression proceeds, the mechanism of sensation is the same. Some physiologists, at the head of whom we find *Gall*, are of opinion, that sensations are entirely produced in the organs to which we have referred them; however, it is more generally admitted, that they require the intervention of the brain; we also coincide, in opinion, with the majority of authors, that the most sensible parts only, feel impressions, which are instantaneously conveyed to the brain, and that it is this last organ only, which decides the impression.

With respect to the act of impression, *Haller, Zimmermann, Bordenæve, Housset*, &c. pretend, that in bodies there exist some insensible parts, unfit consequently for this action; other physiologists deny this assertion; one fact, however is certain, viz. that morbid sensations may develope themselves in all the parts. But in what manner is the impression transmitted to the brain? Here observation ceases. To account for it, a circulation of animal spirit, a nervous fluid, a vibration of nerves, &c. have, in turn, been brought forward, but all these hypotheses have generally been thrown aside. Does the electric

fluid actually perform a part in the production of this phenomenon! This conjecture assumes some appearance of truth, when we recollect, that, in speaking of *innervation*, we have quoted a number of facts, which show the utmost analogy between the nervous and galvanic fluids. Finally, what does the percipient action of the brain ultimately consist of? Here again we must once more plead utter ignorance.

ARTICLE II.

Organs of Sensations.

The nervous system is the organ of every sensation. Nerves are the instruments, in virtue of which, Man perceives impressions and experiences sensations and feelings. Previously to treating of sensations in particular, it appears to me indispensible to take a general view of them. This apparatus is composed of the *brain*, of the *spinal marrow*, of *nerves*, and of the great *sympathetic*. We refer, for a description of the brain, to the chapter treating of moral and intellectual functions.

1st. *The Spinal Marrow,*—is a long cylindrical cord, extended from the occipital foramen to the first or second lumbar vertebræ. It is symmetrically regular in its form, its thickness varies at different points. First expanded at its origin, it contracts to present a new

expansion in the cervical region.* Finally, it terminates inferiorly by an oval tubercle; anteriorly and posteriorly is observed a median fissure, by which it seems to be divided longitudinally into two portions, perfectly similar to each other; in the depth of those fissures is a layer of white substance, which, acording to *Soemmering*, interweaves the two lateral halves, or which merely establishes their continuity, according to *Gall*. On the sides of the two median fissures, we meet with collateral furrows, from which the roots of the cerebral nerves proceed; finally, from the sides, the thirty-two pair of nerves are sent off, where the dentated ligament which separates them is also observable. The spinal cord is outwardly formed by the white substance, and inwardly by the grey, in the shape of two lateral crescents, united by a middle commissure. Finally, similar to the brain, the spinal marrow is lodged within an osseous canal, resulting from the re-union of the twenty-four vertebræ, it is also provided with three membranes, the *dura-mater*, the *arachnoid*, and the *pia-mater*, or *proper membrane*.

2dly. *The Nerves* are cords formed by medullary filaments, reaching from the brain or spinal marrow, to the very depth of the substance of our organs. Passing out from the osseous cavities in symmetrical pairs, nerves successively divide into branches, and ramusculi frequently communicating by means of simple anastomoses, of plexuses, or of ganglia, so

that the whole of this system presents a network in every part of the body. In the minute ramifications, the nerves are devoid of their neurilema; but it has not yet been properly ascertained in what manner they do finally terminate. Some anatomists suppose that they are converted into the very substance of our organs—becoming, as it were, identified with them: others maintain, that they expand into membranes, as appears to be the case with respect to the nerves of the senses. Finally, some are of opinion, that in all the parts they terminate by papillæ. Nerves are formed by filaments of a medullary substance, contained within as many small cellular sheaths, and the whole united in a general envelope, called *neurilema.*

3dly. *The Grand Sympathetic* is a long nervous ganglionic cord, extending along the sides of the spine, from the head to the pelvis, communicating by anastomosing branches with all the spinal nerves, and with a few proceeding from the brain, sending off numerous filaments, which generally accompany the arteries, and are distributed with these vessels to the organs of involuntary functions. This tri-splanchnic nerve commences from a gangliform plexus in the carotid canal and cavernous sinuses; from whence it sends off an anastomosing thread to the sixth pair, to the vidian nerve, and to the fifth pair, through the medium of which it communicates with the ophthalmic ganglion. On the other hand, this nerve descends along the spine; then

it consists of three cervical ganglia, twelve thoracic, five lumbar, four sacral, and frequently of one coccygean. These ganglia freely communicate, by interchanging filaments.

Such is the general appearance the nervous system presents. We have not entered into a minute detail, because a general view of this system,—a sketch of its most striking features, will suffice for the study of its functions. It is not from a work solely intended for physiology, that anatomical knowledge should be sought.

The nervous system we have just described presents (anatomically speaking) an uninterrupted whole. But are these different parts independent of, or are they attached to a centre? In the second place, are they intrusted with the same functions, or is each specially intended for a particular function?

It appears sufficiently demonstrated, at least with respect to man, that this system is subordinate to a centre. Some will have this to be the brain, others the spinal marrow; however, if we look to the most conclusive experiments, we shall find, that the point of re-union of these two parts has strong claims to a preference. With respect to the second proposition, the nervous system forms, it is true, an unique system, every part of which concurs in the immense function of innervation; but it should not therefore be concluded, that each of these parts does

not enjoy an action peculiar to itself. This, however, is an opinion professed even to the present time. This doctrine, which had already been opposed by *Galen* and *Willis*, was shaken to its very foundation by *Bichat*, and completely overturned by *Gall*. This last author divides the nervous system:—1st. Into the nervous system of the *thorax* and *abdomen*,—the great sympathetic; 2dly. Into the nervous system of *voluntary motions* and *tactile sensations*,—the spinal marrow; 3dly. Into the nervous system of the *senses*,—medulla oblongata; 4thly. Into a nervous system of the *faculties of the mind*,—the brain and cerebellum. Since numerous experiments have been made, to determine in a more precise manner, the uses of each portion of the nervous system; I shall state, in as few words as possible, the result of the most remarkable labours, which have been undertaken on this highly important subject. *Rolando* is of opinion, that the brain, through the intermedium of the cerebellum, conveys the principle of motion to the muscles. *Floureus* pretends that the marrow, on a level with the quadri gemina tubercles, is the point at which sensations are perceived; and that, from which the principle of motion regulated by the cerebellum, is conveyed. *Magendie* says, that the faculty of motion originates from the superior part of the brain; that the cerebellum is productive of backward motions; and the cerebral hemisphere of those in a contrary direc-

tion; he adds, that the anterior branches of the spinal nerves are intended for voluntary motion, and that the posterior preside over general sensibility. *Foville* and *Pinel* have placed the seat of sensibility in the cerebellum, that of voluntary motions in the central substance of the cerebral hemispheres; and that of the mental faculties, known under the denomination of *intelligence*, in the cortical substance. *C. Bell* has made some experiments with the view of ascertaining the uses of some particular nerves; he has shewn that the facial nerve presides over the motions of expression of the face, and that the maxillary holds under its dependence the sensibility of this part, and the motions connected with mastication. *Blainville*, who also professes to believe in the plurality of the nervous system, says, that this apparatus results from a series of ganglia, or central parts, each of which presides over particular functions; he adds, that these ganglia are situated at the sides, or at the extremities of a common centre, which he considers to be the spinal marrow. *Bellingeri* has of late endeavoured to demonstrate, by experiments, that the brain holds under its dependence the motions of extension of the limbs, and the cerebellum those of flexion. *Broullard* pretends, that the anterior parts of the cerebral hemispheres preside over speech. *Foville*, on the contrary, places the seat of this faculty in the cornu ammonis, &c.

Such are the principal opinions of modern physio-

logists with respect to the uses of the different parts of the nervous system. In stating these we have been able to remark how widely they differ from each other, how much even they contradict each other; thus, in the midst of all these debates, the question, beset on all sides, still remains unresolved. However, I cannot help mentioning here, that the results obtained by my former colleagues, *Foville* and *Pinel Grandchamps*, are those which, in my particular researches, I have found to be most correct.

ARTICLE III.

Senses of Feeling and Touch.

All the parts of our surface are disposed in such a manner as to receive the contact of external bodies; but one of these parts has a peculiar organization to instruct us of their general qualities: it is the instrument of active sense of feeling, that has received the name of *touch*.

1st. *Organs of Feeling and of Touch.*—The skin is a membrane, which forms a general envelope, and which is reflected on the internal organs, through every natural opening; it adheres to the parts which it covers generally, in rather a loose manner; however,

in some places, where this membrane is united to the deeply situated parts by cellular tissue, it presents a remarkable degree of density, and sometimes is even a ligamentous appearance. In other regions, the skin is lined by a muscular layer, from which it receives motions. The external surface of this membrane is smooth. It offers to our observation—1st. Wrinkles; 2dly. Small papillary projections; 3dly. Hair; 4thly. Small pores, which are the orifices of its follicles.

In the organization of the skin, we meet from within outwards—1st. With the dermis, a fibro-cellular web, from which the skin receives both thickness and solidity, and in the substance of which lymphatic vessels and nerves ramify, to open subsequently on the surface, where they form what *Malpighi* calls the papillæ, or vascular granulations, according to *Gautier*. There is a second membrane resulting from an assemblage of the extremities of vessels and nerves, the surface of which presents a multiplicity of small erectile papillary bodies. This membrane is covered by a new layer, to which *Malpighi* has given the name of mucous body. It is remarkably thin over the papillæ, much thicker in the spaces left between them this sheet, is neither vascular nor nervous; it forms a kind of moist varnish, as it were, containing the pigmentum of the skin. The existence of this membrane has been denied by *Bichat*, *Gordon*, *Chaussier*, &c.; other anatomists, on the contrary, consider this membrane

already remarkably thin, as formed by several superadded layers ; *Gautier*, for instanee, has demonstrated three : a white one, deeply situated ; a coloured one, interposed between this and the third, which is also white and superfieially situated. 2dly, and finally. The epidermis, the most external sheet of the skin. This is an inorganic membrane, which, aceording to some anatomists, is the product of eoagulated albuminous juice ; aecording to others, it is formed by inlaid scales. *Deblainville* represents this sheet as a horny substanee, seereted at the surfaee of the skin. Finally, we observe the organization of the skin to eontain sebaceous follicles and hair, a deseription of which we shnll here dispense with.

The mueous membranes, as well as the skin, are the seat of taetile impressions ; their organization is the same, a mueous layer, termed epiehorion is in this membrane generally, substituted for the epidermis.

The hand is the organ of toueh ; plaeed at the extremity of a very moveable lever, it combines in its organization, both exquisite sensibility, and remarkable mobility. The frame work of this organ eonsists of twenty-seven bones, disposed in three flexible parts—the one above the other. The *carpus*, or the *wrist*, the *metacarpus* forms the palm of the hand, and the *fingers* (five in number,) in which there are several articulations. Numerous museles are destined to give multifarious, general, and partial motions, to all these

parts. Finally, a very remarkable skin, and closely united to the subjacent parts, covers the hand; the nervous papillæ are very much developed, particularly at the extremeties of the fingers, where the skin rests upon a spongious tissue, considered by some physiologists as being erectile; the nails situated on the back part are intended to sustain the pulp of the fingers.

2dly. *Mechanism of Feeling and Touch.*—The mechanism of touch is remarkably simple; the skin, which is the organ, is continually submitted to the contact of external bodies, consequently this membrane must incessantly develope the impressions. Feeling is effected without the slightest action being observable in the organ, which is the instrument of the function. Thus it is impossible to say precisely in what it consists. Every thing tends to prove only that the seat of the impression is in the papillæ, and that the epidermis modifies the action. By touch, we are enabled to appreciate *weight, consistence, motion, extent,* and particularly the *temperature* of *bodies.* In fact, it is by touch alone that we experience the sensations of *heat* and *cold.* But the judgment we form of these two qualities in bodies, is not precisely connected, as might be supposed with the quantity of caloric, they either yield or absorb, because we always compare their temperature with that of the atmosphere, in which we live, and to which our body is accus-

tomed; so that, for instance, a body may appear hot, because the temperature of that body is superior to that of the atmosphere, although, perhaps, it may be below par with respect to our own.

The mucous membranes also are the seat of tactile impressions, but at their origin only; every body is acquainted with the exquisite sensibility of the lips, of the vagina, &c. &c.

Of Touch.—Touch is nothing more than active feeling, effected by a spinal organ, constructed in such a manner as to be enabled to seize the surfaces of bodies, and to adapt itself to their forms. We have seen that the hand possesses every favourable condition for the accomplishment of this function. From time immemorial, philosophers have admired the organization of the hand, they have even gone so far as to attribute to this organ the superiority of man over animals. It was called by *Galen* the instrument of instruments. The mechanism of touch is the same as that of feeling, the impression unfolds itself precisely in the very same manner, but it is more perfect, because the contact itself is more complete.

Coudillac and *Buffon* allowed touch to possess considerable superiority over the other senses; some philosophers, considering its precision, gave it the name of a geometrical sense, others called it the regulation of senses, &c. But it actually is entitled to no superiority whatever, as *Destutt-Tracy* has very clearly proved.

It cannot be denied that this function most powerfully assists the intellects, but as much might be said with respect to every other sense.

Touch admits of being improved by practice, to an astonishing degree. Blind subjects have been seen to perform the most delicate mechanical operations.

There are two peculiar sensations, which, in my opinion, ought to be connected with the history of the preceding, because they generally arise from contact of a foreign body with the skin, or with the origin of the mucous membranes. The one is *pruritius* or *itching*, the other *tickling*. The first may be owing to some internal cause, but most frequently it proceeds from feeling and touch. Both require a slight and unexpected contact, in order to be experienced.

ARTICLE IV.

Sense of Taste.

By this sense we make ourselves acquainted with the savour of substances.

1st. *Savours.*—This name is indiscriminately given to the impression conveyed by a sapid substance, and to the integral particle of the substance from which the sensation arises. We shall consider it under the last point of view.

We are totally unacquainted with the conditions re-

quisite to make integral particles sapid. Authors have at times resorted to geometrical forms to account for the variety of savours: for instance, it was said that a rounded form was productive of a sweet sensation, that a sharp one proceeded from an angular form, &c. The different savours of substances are now generally attributed to the chemical nature of their particles.

As the number of savours simply, is almost unlimited, and the number still further increased by the circumstance of their not producing the same impressions upon every individual, it is impossible to form a classification, comprising the whole. Savours, however, may, with respect to every individual, be divided into *agreeable, disagreeable,* and *mixt.*

2dly. *Organs of Taste.*—The tongue is the principal organ. The lips, and every other part of the mouth, the pharynx, and even the stomach, are susceptible of receiving a slight impression from the contact of savoury substances. These parts have even sufficed to restore taste with some individuals who had lost the organ. *Ruysch* admits of the existence of papillæ.

The tongue is a mascular body, having the form of a cone, placed from above downwards; situated in the mouth, which it nearly fills, this organ adheres to the lower part of the body by its inferior surface, and to the os hyoides by its base; the whole of the remaining part of the organ being perfectly free. In the organization of the tongue we observe muscles which con-

stitute the body, and a membrane that encloses these muscles, intended to receive impressions from savours.

The muscles are, 1st. *Extrinsic:* the genio-glossus, the mylo-glossus, hyo-glossus, and the stylo-glossus, which move the tongue entirely. 2dly. *Intrinsic:* These specially form the tongue, and give it partial motion. Formerly, the lingual only, was known, but *Gerdy* has discovered in the tongue a superficial lingual, a transverse lingual, a vertical lingual, oblique linguals, and an elastic yellow tissue, occupying the base. Over the median line of the tongue, *Blandin* has met with a fibro-cartilaginous sheet, giving insertion to the transverse muscles, and which he considers the lingual extension of the os hyoides.

The membrane that forms the envelope of the tongue is a continuation of the skin, modified in a special manner, to become the seat of a special sense—of taste, at the upper surface of the organ. On this surface the papillæ are much developed; and it is generally admitted, that they result from the last ramifications of the lingual nerve, which are surrounded with an erectile spongious tissue, to which is attributed their projection and partial power of erection. In consequence of their forms, they are divided into *pyramidal*, *fungiform*, and *filiform*.

3dly. *Mechanism of Form.*—Of all our senses, taste is that which by the simplicity of its mechanism ap-

proaches the nearest to touch. This sense consists of as follows: the *tongue,* which by *meeting,* or what is more generally the case, by *receiving* sapid bodies, brings its nervous papillæ in contact with these substances; from that very moment impression takes place, and the perception of this impression is transmitted to the brain, through the medium of the lingual nerve. This, however, has given rise to some disputes: *Boerhaave* pretends, it is through the grand hypo-glossal nerve, that the transmission is effected. *De Blainville* says,it maybe possible that the three nerves of the tongue concur in this result. The greater number of modern physiologists, however, concur with *Haller* in thinking that the *lingual* is the only nerve calculated to produce the sensation of taste. Professor *Richerand* has clearly ascertained by the application of galvanism, that this nerve is possessed of less mobility than any other.

There are particular sapid bodies which produce a more or less durable impression. This is what is terméd *after taste.*

The sense of taste, which is stationed on the course of the digestive apparatus is more subservient to nutrition than to intelligence; it is entirely under the influence of the will, and admits of great perfection.

ARTICLE V.

Olfactory Sense, or Smelling.

By this sense we make ourselves acquainted with odours.

1st. *Odours.*—This name has been given to the most volatile particles, which arise from odoriferous bodies, and produce in us, that sensation which has received the name of smell. Previous to *Fourcroy* and *Bertholet*, it was supposed that odours existed independently of every substance concurring in the composition of bodies. These two authors, however, have demonstrated, in the most satisfactory manner, that odours are nothing more than the very particles of odoriferous bodies dissolved, or in a state of suspension in the air, after having been volatilized by caloric.

Odours are diffused around the bodies, from which they arise, and the fragrance gradually decreases as they recede from their origin; they follow no determined direction, and absolutely obey the impulse given by the atmosphere; some odours admit of wonderful expansion, and are conveyed at considerable distances. The fragrance of cinnamon, for instance, according to *Boyle*, warns the mariner, of a distance of upwards of 25 miles, that he is approaching Ceylon.

Odours, so very remarkable by their unlimited varieties, vary also with respect to individuals, for which reason a perfect classification is impossible. But ac-

cording to the sensation they produce, odours may be divided into *pleasant* and *offensive*. *Haller* had admitted of a third genous, including *mixt* odours.

2dly. *The Olfactory Organ* includes—1st. A parallelopiped (cavity called the fossa nasalis,) curved in the substance of the face below the forehead, and above the mouth; this cavity is divided into two symmetrical lateral halves, by a median partition, each of which has individually received the name of fossa nasalis, and presents a superior concave wall, formed by the bridge of the nose, the cribriform portion, and the body of the sphenoid. An inferior portion, inclined backwards, formed by the palatine portion of the maxillary and the os palati; an internal partition, formed by the vomer and perpendicular blade of the ethmoid bone: an external wall, inwardly inclined, formed by the os unguis, the maxillare superior, the os palati, the inferior *chamber*, and ethmoid. The olfactory organ presents three *chambers*, from above downwards, separated from each other by the same number of *meati*.

The fossæ nasales are deeply continued in the adjacent bones by secondary excavations, called the *frontal*, *ethmoidal sphenoidal*, [and *maxillary sinuses*. The fossæ nasales open backwards into the pharynx; and on the forepart by a triangular pyramidal projection, situated in the middle of the face, and called the *nose*.

2dly. *The Olfactory Membrane* is a mucous sheet:

it lines the fossæ nasales throughout their extent, and is reflected into the *sinuses* and *meati.* This membrane which receives a large quantity of vessels and nerves, secretes abundance of mucus, which keeps its surface in a state of humidity, favourable to smelling.

3dly, and finally. The *olfactory nerve*, which is the special agent of smell. This nerve originates, according to *Bichat* and *Beclard*, from the medulla oblongata, from whence it proceeds passing below the anterior lobe of the brain (here being distinct) and passes through the cribriform bone into the foramina, by as many small threads, which ramify in the pituitary membrane, particularly in its superior part : these threads have never been traced beyond the middle chamber.

3dly. *Mechanism of Smell.*—The mechanism of this sense is very simple. In order to reveal the whole mystery, it will suffice to bear in mind, that the olfactory apparatus is situated in the course, which air most frequently takes to enter the chest, and that this air is the vehicle by which odours are wafted. The following observations will, in addition, explain what actually takes place. In the act of inspiration, the nose, by reason of its direction, draws into the superior part of the nasal fossæ, the air, which is loaded with odoriferous particles, and by which these particles are deposited upon the papillæ of the olfactory mucous surface; by this contact smell is immediately developed, and is instantly propagated along the ethmoidal nerve

to the brain, which perceives the impression. Most physiologists are of opinion, that the mucus of the nose serves to keep up the suppleness and sensibility of the nervous papillæ, and to dissolve the odoriferous particles, so as to blunt the impression which might be too vivid, if it were immediate. In some circumstances, odours penetrate into the nasal fossæ, by the mere action of their power of expansion, which induces us to cover the nose when these odours are of an offensive nature.

With respect to the uses of the chambers and sinuses, we shall find that opinions are divided; previously to enumerating them, let us recal to mind that the olfactory nerve has been traced no further than the middle chambers, that this nerve does not penetrate into the sinuses, and, consequently, that the superior, part only of the pituitary membrane is the seat of smelling. A number of physiologists assert, that the chambers are intended for no other purpose than that of multiplying the olfactory surfaces; some have attributed the same office to the sinuses. *Richerand* created no sensation by injecting odours into the maxillary sinus. This physiologist is of opinion, that these cavities are no otherwise serviceable to smelling, than by retaining for a longer space of time, a greater quantity of odoriferous particles. *Magendie*, in common with several other authors, pretends, that the sinuses are of no other use than that of supplying the nasal fossæ with a greater proportion of mucus.

By this sense we become acquainted with odours; it also informs us of the quality of our food, and of the air we breath. Some philosophers also attribute to this sense the faculty of recognising localities; *Rosseau* called it the sense of imagination, on account of the manner in which odours act upon the nervous system. But for this reason it might, under some peculiar circumstances, be termed the sense of love.

Smelling is under the control of the will, and we may exercise it either actively or passively; it admits of improvement, by habit.

ARTICLE VI.

Sense of Sight.

By this sense we judge of the size, figure, distance, and particularly of the shape of bodies.

1st. *Light* is a fluid, subtle, in a pre-eminent degree, not coercible, placed between the eye and lighted or luminous bodies, the existence of which it enables us to ascertain. According to *Descartes*, it is œther universally extended, the particles of which are put in motion by the internal oscillations of bodies. According to *Newton*, on the contrary, light eminates from the sun, and other luminous bodies. From this hypothesis, which is generally admitted, bodies are visible only because

they reflect a part of the light they receive. A few modern philosophers have attempted to refer every phenomenon connected with light to a vibratory motion in bodies.

Light, proceeding from any body whatever, forms diverging cones, which invariably move in a straight direction: In the space light travels, three things may occur: 1st. Light may reach the eye directly without having met with any obstacle in its course; 2dly. This fluid may be partially or totally reflected by an opaque body. In the first case, it conveys the image of the reflecting body; in the second, it transmits that of the bodies from which it primitively originated: The angle of reflection is invariably equal to the angle of incidence. 3dly. Whenever light meets with transparent bodies of different nature and degrees of density, this fluid undergoes a change, called *refraction*. When a luminous ray plunges from a rare medium into a more dense medium, it approaches nearer to a perpendicular line, it recedes from it on the contrary, when sent from a dense body to a more rare. If the refringent body is formed of parallel surfaces; the rays do not deviate from their primitive direction, the refraction they have undergone by entering the body, is corrected by that which takes place on their emerging from it. If the refringent body has a lenticular form, the rays undergo such refraction as to converge to a point, which is called *focus*. If the

convexity of the lens be somewhat considerable, the rays will not re-unite in the same focus, so that, the images are traced in too wide a circle; this causes an inconvenience called *aberration of sphericity*, which may be remedied by covering a part of the lens. If the refringent medium, on the contrary, is a concave surface, the refraction is such that the rays become divergent, and their focus is formed anterior to the concave body, at the point of immersion.

The white light, as is sufficiently known from the experience of the prism of *Newton*, is composed of coloured rays; each of these rays yields in a different manner to the refringent force, so that they constantly undergo a dispersion, which gives to the object, the colour of the solar spectre. This is an inconvenience, remedied by achromatics. Such are the general ideas of optics, which I have considered indispensable for the better understanding of vision.

2dly. *Organs of Vision.*—The organs of vision consist of the accessory parts (*tutamina oculi,*) of the eye, and of the optic nerve. The protecting parts of the eye are the *orbits,*—osseous cavities, which contain the muscles of the eye; a bed of fat, on which this organ softly rests; of the *eye-brows*, kind of curved projections, provided with hair, and closely shaped upon the superior ridge of the orbit of the *eye-lids*; two muscular membranous kind of moveable veils, intended to expose the eye to, or screen it from, the contact

of luminous rays, according to the dictates of the will: These veils consist of a superior and an inferior, and are united at their extremities; from their degree of separation results the apparent volume of the organ. Their internal surfaces are provided with a mucous membrane, which is subsequently reflected over the globe of the eye, and terminates at the circumference of the cornea. According to *Ribes* it is called *conjunctiva*, because it unites the eyelids with the globe of the eye. The free edge of the eyelids is provided with short hairs curved outwardly, called the eye lashes, this part also contains a great number of small follicles. Finally, there is a secretory apparatus, commissioned to supply the organ with a smooth albuminous fluid, by which the surface of the eye is lubricated, and which facilitates its motions. This fluid has been described in speaking of *secretions.*

The eye, by its organization, perfectly resembles an instrument of optics, being actually similar to a telescope: this organ is found to contain—1st. An external envelope, that forms the frame work, the interior of which, perfectly black, has a perfect resemblance to the camera obscura. 2dly. Refringent bodies, calculated to re-unite the luminous rays into given foci. 3dly, and finally. A membrane perforated in the centre, for the purpose of rectifying the aberration of sphericity. The eye is possessed of all these parts, and moreover of a nervous organ, on which the luminous foci that develope the impression meet.

The Sclerotic is a fibrinous membrane, which has the form of a truncated cone before, and is perforated behind, to give passage to the optic nerve; this membrane forms the walls of the instrument, and gives insertion to the motor muscles of the eye.

The Choroid is a brown, soft, vascular membrane that lines the preceding, and similar to it, is perforated behind for the admission of the optic nerve: this membrane is also truncated in its anterior part, where it corresponds with the larger diameter of the iris. The choroid is formed by the interweaving of the ciliary arteries and veins disposed into two sheets, the most internal of which is called *membrana ruyschiana.* This membrane is covered with a brownish pigment; it is this membrane that makes a camera obscura of the eye.

The Cornea is a transparent convex membrane, inserted into the anterior circumference of the sclerotic; its anterior surface, which projects considerably, is endowed with a particular mucus; the posterior is lined by a membrane of the aqueous humour. This forms the first refringent body of the eye.

The Aqueous Humour is a transparent fluid, occupying the space between the cornea and the chrystalline lens. This space is divided into two parts by the iris: they form the chambers of the eye. It is generally supposed, that this humour is secreted by a proper membrane, which has been described by *Demours.*

The aqueous humour is the second refringent body; it assumes a convex form before, and is concave at its back part.

The Chrystalline is a transparent lens, somewhat less concave before than behind, situated at the point at which the anterior third of the eye unites with the two posterior thirds; it is lodged within a separation, formed by the sheets of the hyaloid membrane. This organ is composed of a proper membrane, that secretes the chrystalline humour; it is disposed in *ellipsoid* concentric layers, which become more dense as they become deeper. Most anatomists consider the chrystalline as an inorganic substance. It forms the lens of the eye, the surface of which is lubricated by a viscid humour, called the humour of *Morgagni.*

The vitreous body is a humour perfectly transparent, occupying the three posterior fourths of the eye, circumscribed on all sides by a very thin membrane (the hyaloid), which sends off prolongations, that divide its cavity into cells, freely communicating with each other. By this membrane is secreted the humour with which the vitreous is filled; it unfolds its anterior surface, to receive the chrystalline lens. The vitreous body presents a concave surface in front, and is convex behind: it is the last refringent body of the eye.

The Iris is a cellular membrane, inserted into the anterior circumference of the choroid; the iris is per-

pendicularly situated between the chrystalline lens and the cornea. The centre of this membrane is perforated, and the dimensions of the opening vary according to the intensity of light (pupil:) its posterior surface is stained by a substanee nearly black. Anatomists do not agree with respect to the structure of the iris; some call it muscular, others maintain that it is vascular and nervous. It serves the office of a curtain, by which the aberrations of sphericity occurring in the lens are rectified.

Opposite to the insertion of the iris, a kind of greyish ring (*ciliory ligament*) is observable, by which this membrane seems to be secured. Behind the circumference of the iris, we meet with small vascular membranous triangular bodies, stained with a black pigment (*eiliary processes*,) from sixty to eighty in number; they are extended from the eircumference of the choroid to the anterior part of the vitreous humour, and of the lens; the nature of these small bodies has not yet been properly aseertained. *De Blainville* viewed them as folds of the choroid; *Ribis* took them to be the secreting agents of the humours of the eye. From their erectile nature and situation before the circumference of the ehrystalline lens, they may be regarded as a second curtain. The eye, we have said, reunites in its structure, besides what is required for an instrument of optics, also organs that reeeive the image and transmit it to the brain: such are the re-

tina and optic nerve. The *retina* is a pulpous greyish membrane, of a light lilac colour, situated between the choroid and the vitreous humour; it is formed by the expansion of the optic nerve, and a few ramusculæ of the central artery of *Zinn*. At a distance of two lines outwards from the optic nerve, and in the axis of the eye, this membrane presents a yellow spot, termed the spot of *Soemmering*. Finally, the optic nerves, originating from the anterior pair of the quadrigemina tubercles, increase in bulk by the addition of filaments sent off from by the *corpus geniculatum externum*, and the *tuber-cinereum*, and uniting on a level with the cella tursica, they ultimately expand, so as to form the retina. Six small muscles lodged within the orbits, give to the eye the different motions this organ admits of.

3dly. *Mechanism of Vision.*—The luminous rays emanating from a luminous body, form a cone, the base of which falls on the cornea. This membrane, owing to its polished condition, reflects a few rays of light, which give it that degree of brilliancy we are all acquainted with. The remainder of the cone, after having undergone divers refractions, penetrates into the eye, to give the impression to its nervous organ. The fasciculus, which occupies the centre of the cone, is parallel with the axis of the eye; it falls perpendicularly upon the summit of the refringent bodies, and reaches the retina, without undergoing any refraction;

but with respect to the rays of the circumference of the eone, they act as follows:—1st. By erossing the cornea, they are brought nearer to their own axis, and for this reason increase in intensity. 2dly. In entering the aqueous humour, where the power of refraction is somewhat less than in the cornea, they slightly diverge from the perpendicular; in eonsequence of which, some fall upon the anterior part of the iris, which reflects them in part: and hence are produced the variegated colours of this membrane. 3dly. The rays that cross the pupils are those only which serve for vision; they pass baekward, and strike upon the anterior face of the ehrystalline lens; some of them, in consequenee of the polish of this body, are returned; others are absorbed by the black substance of the iris, and of the eiliary proeesses; but the greater number of rays crossing the lens, are powerfully refraeted, and, in consequenee their intensity is considerably inereased. 4thly. The faseiculi, having thus eonverged, eross the vitreous body, which eontinuing the effect of the refraetion of the lens, or even inereasing the convergeney of the rays, they ultimately reunite round their axis upon the retina, at a point ealled the *Focus*. By this membrane (the retina) the sensation is developed; the portions of light that eross it are absorbed by the choroid. Thus, in passing through the eye, the luminous rays form another eone, the base of which corresponds with the eornea, and the summit with a point of the retina.

The fasciculi of light that are given off from the superior, and from the inferior parts of any visible object, cross each other in that part of the lens, called its *optic centre*; so that the object is represented in the depth of the eye in an inverted position. How does it happen then that we perceive it erect? *Buffon* would have it, that this error was rectified by touch. *Berkley* says, that, in fact, the image is inverted in the eye; but as we see ourselves in that position, we judge of the position of bodies, comparatively with our own.

How does it happen then that man, being provided with two eyes, does not see objects double? *Buffon*, to explain this unity of vision, has resorted to touch; *Ackermann*, to the reunion of the two optic nerves. Metaphysicians have said, that the impression should be distinct from the perception, which is always simple. *Gall* pretends that one eye only is actively engaged at a time, &c.

The extent of sight, although differing but little in individuals, is however restricted. 1st. If the object be too small, it does not send off a sufficient number of luminous rays to be perceived: by bringing it nearer to the eye, the rays become too divergent, the organ has not sufficient power left to reunite them on the retina. Again, if the volume of an object be ever so large, when placed at a certain distance, the eye ceases to see it, because its refringent power is too inconsiderable to reunite the widely diverging rays. At a

given distance also objects cease to be perceptible; either because the rays have been absorbed in their course, or that the image has become too small to be seen; or, owing to the refringent power of the eye, they may too much increase, and the rays unite opposite to the retina. These two extremes of vision constitute *Myopia* and *Presbyopia*.

It is generally admitted, that the eye undergoes some internal modifications to be enabled to see at different distances; it is certain, however, that the pupil contracts more as the object is nearer. But what has not been quite so correctly ascertained, although it is rather generally admitted, is the elongation of the eye by the oblique muscles of that organ, its contraction by the straight, the increase of curvature of the cornea, and the displacing of the lens.

The description, purely *physical*, which we have just given of the mechanism of vision, presupposes that the eye is perfectly achromatic; and, in the next place, that the refringent bodies are so connected with each other, that they cause the luminous rays to converge on the retina.

Sight, as well as every other sense, is directly subservient to the intellectual faculties. With respect to the importance of its attributes, physiologists are much divided; some, such as *Coudillac*, *Berkley*, &c. consider it as a subordinate sense; others have much exagerated its importance.

ARTICLE VII.

Sense of Hearing.

Hearing is the sense by which we become acquainted with sounds.

1st. Sound is the sensation felt when the vibrations, communicated to a sonorous body, strike the ear: all the forces, in fact, which are received by a body, create a vibratory motion in the molecules of that body, which are communicated to the layers of air successively, till they reach the ear, where they determine the sensation of sound. We cannot precisely specify what are the physical qualities required for a body to be sonorous; all we know is, that the sound, generally speaking, is in a proportional ratio with the solidity and the elasticity of the sonorous body.

Tone (*Le Ton*) proceeds from the number of vibrations produced within a given time: the more they are multiplied the more acute is the sound: from thirty-two to seven or eight hundred vibrations are the limits for appreciable sounds. Whatever exceeds these limits is denominated noise.

The *Tune* (*Le Timbra*) of sound is generally supposed to proceed from the nature of the sonorous body; *Biot* thinks *tune* is owing to the harmonic sounds by which a fundamental sound is invariably attended.

The velocity with which sonorous undulations are conveyed through the air, is excessively great; it has been estimated at one hundred and seventy-three fathoms in every second. Water, and every other elastic fluid, is calculated to propagate sounds.

2dly. *Organs of Hearing.*—This organ is situated on each side of the head, towards the base of the cranium, it consists of—

The External Ear, composed of the cartilaginous part, a sort of winding acoustic shell, formed by the external skin, and fibro-cartilage, from which it receives its form, and possessed of internal and external muscles, of the *auditory canal,* about an inch in length, extending from the concha to the tympanum. This canal consists of an osseous portion, a fibro-cartilage, and of skin, which in this part is provided with follicles much developed, and denominated *ceruminous,* on account of the humour they secrete.

The middle Ear, or Tympanum, forms an irregular cavity in the petrous portion of the temporal bone, outwardly separated from the auricular duct by the membrane of the tympanum; and inwardly communicates with the internal ear, by the means of two openings, known by the names of *fenestra ovalis* and *rotunda,* which are closed by a dry, vibratory membrane, similar to that of the tympanum. Below, we observe the *glenoid fissure,* giving passage to the ante-

rior muscle of the malleolus, and to its long apophysis. Backwards, we meet with several openings, communicating with the mastoid cells. Finally, in front, is an osseous and cartilaginous canal, which opens at the superior and lateral part of the pharynx, giving a free communication for air (*the eustachian tube.*)

The cavity of the internal ear, which is continually filled with air, and lined with a thin membrane, is crossed by a chain of four delicate bones, articulated together by diathrosis; moved by small muscles, this chain represents a curved lever, extended from the membrane of the tympanum, to that of the fenestra ovalis, and gives to this membrane different degrees of tension. These bones are the *malleus*, *incus*, *stapes*, and the *orbiculare*.

Internal Ear, or Labyrinth.—This part includes the cavities, communicating with each other, namely:—1st. The *vestibulum*: a small excavation, of a rounded form, situate between the tympanum and the internal auditory canal, giving passage to the acoustic nerve. Seven openings are observable in it: Outwardly, to the fenestra; and in front we also meet with the orifice of the cochlea, and in the remaining portion of its extent, with the five orifices of the semi-circular canals. 2dly. *The Cochlea*, an osseous cavity, formed of two spiral canals, and sustained by a centre, called the axis. This axis is perforated by a number of small foramina, giving passage to the nerves of the cochlea.

The two spiral canals are separated from each other by an osseous and membranous partition; the external spiral opens into the vestibulum, the internal communicates with the fenestra ovalis. 3dly. *The semicircular canals*, three in number; two of which have a vertical direction, the third an horizontal; they leave between them a small triangular space, filled with diploe: these canals open in the vestibulum.

All these cavities are lined by a thin membrane, from which a thin transparent fluid, the humour of *Cotunnius*, is exhaled, and which receives the last fibres of the auditory nerve. The origin of this nerve, from the *corpus restiforme*, is sufficiently known.

3dly. *Mechanism of Hearing*.--The external ear, owing to its funnel-like form, collects the sonorous undulations, and transmits them to the auditory canal. *Boerhaave* even says, that its divers curvatures are a geometrical arrangement to this effect. In the first course, sounds reunite, and for this reason increase their intensity; they pass through the auricular canal, and soon reach the membrane of the tympanum, to which they communicate their vibrations. This last organ, being thin, dry, and elastic, like the skin of a drum, consequently well calculated to reecho sounds, transmits them to the internal ear, in three different ways: Namely—by the chain of small bones, by the wall of the tympanum itself, which is dry; finally, by the air, that fills that cavity. Next, the

membranes of the fenestra ovalis, of the fenestra rotunda, and of the vestibulum, which are equally dry with that of the tympanum, partake of the oscillations, and transmit them to the water of *Cotunnius*. Finally, this humour, which fills the labyrinth, applies the vibratory undulations to the nervous fibres, which float in its interior, and the impression resulting from this contact, is ultimatelytransmitted through the acoustic nerve to the *common sensorium.*

Sound in some cases is known to assume a different course. For instance, on stopping up both ears, we shall hear the watch held between the teeth; it is said, that in such cases, the sonorous undulations are transmitted through the bones of the skull. This is highly probable; for we are aware, that, under particular circumstances, solids are very good conductors of sound.

Such is the physical summary of a history of the sense of hearing; positive information with respec t to this sense goes no further. But physiologists have attempted to determine, in a more particular manner, the special part each individual portion of the ear performs. Upon examining the divers hypotheses on this subject, we shall find they are far from throwing any light upon this phenomenon. *Dumas* considers the *membrane of the tympanum,* as formed of concentric curved lines, of each of them having the property of vibrating a particular tone. Others have said,

that, from the degree of tension of this membrane results the difference of tone. The tympanum has been considered by some as calculated to lessen the intensity of sounds, and by others to increase it.

With respect to the small bones of the ear, it has been asserted, that their action consists in striking either against each other or against the membrane of the tympanum only. It is obvious, that such an hypothesis does not merit a refutation. Independently of the office we have already ascribed to these diminutive organs, it has generally been admitted that they modify the degress of tension of the membrane of the tympanum, and of the fenestra ovalis.

The Eustachian Tube.—Is this tube intended for no other purpose than that of renewing the air on the tympanum? Some physiologists contend, that this canal may also be intended for the admission of sonorous undulations. The same has been asserted with respect to the *membrane of the vestibulum*, at times it has been considered as composed of vibratory zones; at others, it has been asserted that the intensity of sound is modified, or even different tones produced by its different degrees of tension. *Cotunnius* supposed that the lymph, which fills the labyrinth, is circulated in the semi-circular canal and in the cochlea, by the effect of sonorous vibrations. *Lecat* viewed the *cochlea*, as an instrument intended to develop and produce the sound. *Boerhaave* entertained nearly the

same opinion, with respect to the semi-circular canals. Some of this author's contemporaries thought they were filled with different fluids, admitting of different modes of vibration.

The sense of hearing is one of the most indispensable to intelligence; a few metaphysicians have placed vocal language, music, &c. amongst its attributes. Without, however, being the source of these faculties, it certainly is materially subservient to them. Similar to every other sense, it admits of perfection by practice, and may be exercised either passively or actively, that is to say, by *hearing* or *listening*.

ARTICLE VIII.

Internal Sensations.

These sensations are inward feelings, which are spontaneously developed in our organs, without the intervention of external bodies. The will has no power over them. We can neither develop nor suppress them at command; these sensations bear a peculiar character, that of being more or less gratifying of assuming the character of pleasure or of pain, accordingly as they are indulged or resisted.

Internal sensations may be divided into three classes.

1st. Some warn us of the want of action, which our

organs stand in need of. Such are, the want of *drinking*, of *eating*, of *respiring*, as well as those connected with secretions, to which may be added, the want of *connection between the sexes*, also that of labour; and finally, the *want of moving, speaking, of exercising* the intellectual functions, &c.

2dly. By the others we are warned of the reverse, they manifest themselves after the organs have acted; to this class, the wants of *rest*, of *sleep*, of *leisure*, of *relaxation*, &c. are referable.

Finally, the third class includes the sensations that occur whilst the organs are active. Such are those that warn us of our motions, and even those by which we are made sensible of our own existence.

Most of these sensations are related with a function, or form a part of it. To the history of the latter, we shall refer for their description; however, it will be proper to state before hand, that their mechanism is unknown, and that the whole of our seience is limited to observation.

Morbid Sensations.

Pain, and all its varieties, are morbid sensations, which may manifest themselves in all the parts of the body, under the influence of different physical or organic alterations, intended to warn us of the destruction, that threatens the economy; these sensations

are unlimited, no language can enumerate their varieties: the ancients referred them to four species, viz. *dull* or *heavy*, *tensive*, *lancinating*, and *biting* or *gnawing* pains. With respect to their mechanism, it is the same as that of sensations in general.

CHAP. II.

INTELLECTUAL MORAL FUNCTIONS.

There is in the economy a particular order of functions that forms the most noble, and the most characteristic attribute of man, and secures his preeminence over all other species. For a considerable length of time, the acts of these functions, (the study of which constitutes *Psychology*,) were considered as an immediate and exclusive result of the operations of the soul; and men, perfect strangers to physiology, decorated with the pompous title of metaphysicians,* had appropriated them to themselves. But, supported by indisputable argument, which shall be hereafter produced, physiologists have at last regained this, their most noble appendage.

These new faculties, the science of which we have

* Metaphysician, from μῆτα-φυσις, above physics, beyond what falls under the senses.

said before, constitute psychology, are naturally divided into *intellectual* and *affective:* they belong properly to the moral man.

We shall begin the history of these functions by that of the *encephalon*, and lay down in a second article the analysis and uses of these faculties, without indulging in any conjecture with respect to their organs. In a third, we shall endeavour to determine the material agents of the functions, for a number of physiologists are still very far from considering the brain as the instrument of these functions. A fourth chapter will contain an account of the sources from which this agent borrows the materials upon which it acts. In a fifth will be unfolded the divers modifications this organ and its functional acts are liable to undergo under the influence of various circumstances. Finally, in a sixth chapter, we shall treat of the divers means of divination employed to judge *a priori* of the development of these faculties.

ARTICLE I.

Of the Brain.

The description of the brain partly belongs to the history of sensations, since, as we have seen in studying the latter, it is both the recipient and the percipient organ. But as, on the other hand, it is also the instrument of the series of moral acts we are about to

study, we have thought it advisable to make the description of the brain follow immediately the chapter of sensations, and to place it at the head of the intellectual and affective faculties.

The brain is a large symmetrical nervous mass, contained within the cavity of the skull, and it is composed of three different parts: the *medulla oblongata*, the *cerebellum*, and the *cerebrum.*

1st. The *medulla oblongata* forms the base of the brain, extending from the large occipital hole to the posterior plate of the sus-sphenoidal fossa. It presents, for consideration—1st. At its anterior extremity, two voluminous extensions, the *peduncles* of the *cerebellum*, which are extended into the cerebral hemispheres, originating from their expansions; 2dly. On the sides, two less voluminous prolongations, the *peduncles* of the *cerebellum*, which enter in the same manner into the lobes of the latter; 3dly. The *medulla oblongata*, at its posterior extremity, is directly continuous with the spinal marrow by a third extension, called the *spinal bulb.* It presents below, two pair of eminenees, the *corpora pyramidalia*, the *corpora oblivaria*; above, two more, called the posterior pyramids, or corpora restiforma, which separate from each other from behind forwards, so as to make a triangular depression, which forms part of the fourth ventricle of the brain, the angle of which, remarkably acute, assumes the name of *calamus scriptorius.* Fi-

nally, these different parts are reunited into a central point by a kind of knot, the *pons varolii,* the *meso-cephale,* of Chaussier; its surface rests on the basilar process, the superior is concealed by the lobes of the cerebellum and of the cerebrum, presents from before backwards the *quadrigemina tubercles* (*nates* and *testes,*) below which we meet with the *aqueduct* of *Sylvius*; the valve of *Vieusseus;* finally, a concave surface, which, jointly with that of the spinal bulb, forms the posterior wall of the fourth ventricle.

The Cerebellum.—The cerebellum is an organ of an irregular oval form, depressed from above downwards, situated in the inferior or cerebellous fossæ of the occipital bone above the medulla oblongata, below the posterior lobes of the brain, from which it is separated by the tentorium. The upper surface of *the cerebellum* presents a median projection, the *superior vermiform process*; the under part is also provided with a similar process called the *inferior vermiform,* and there is rather a deep depression, in which the spinal bulb is lodged. In the anterior portion of the circumference, the peduncles sent off by the medulla oblongata are received. The whole surface of the cerebellum is deeply divided by many fissures into regular and concentric blades; which blades are themselves subdivided into much more numerous parts.

The cerebellum is formed externally by the grey cortical substance, and inwardly by the medullary

white substance; in the eentre of the latter we meet with a circular grey fringe, called the *rhomboidal body.*

The Cerebrum is the most eonsiderable part of the encephalon: situated before and above the preceding, it fills up the whole cavity of the cranium, exclusive of that part included under the tentorium of the cerebellum. Viewed in a general manner, the brain is rather of an oval form; on its surfaee are observed a number of undulated eminences (*the circumvolutions,*) separated from each others by deep fissures, called *anfractuosities.* The brain consists of two lateral symmetrieal halves, named the *hemispheres,* separated at their superior part by a longitudinal furrow; and, on the contrary, reunited in their middle and inferior parts by the eorpus eallosum or *mesolobe.*

Viewed at its base, the brain presents—1st. Over the median line, from before baekwards, the anterior extremities of the *corpus callosum;* a membrane of a grey substance, which runs from this extremity to the reunion of the optic nerves; the eommissure of these nerves, the *tuber cinereum,* the *shaft,** and the *pituitary gland,* the *mamillary tubercles,* moreover, a transverse fissure, described by *Bichat,* and through which the pia-mater and the arachnoid enter into the ventricles; and, finally, the posterior extremities of the corpus callosum. On the sides, we observe, the inferior faee of eaeh hemisphere, whieh appears to be divided

* La Tige

into three lobes. The *anterior* resting on the orbitary vaults, the *middle lobe* separated from the former by the fissure of *Sylvius,* and the *posterior* supported by the tentorium of the eerebellum.

The internal organization of the brain presents a number of remarkable parts, whieh we will briefly enumerate—1st. On the median line, we observe the *corpus eallosum* or *meso-lobe,* the *septum lucidum,* which eontains the *fifth ventricle;* the areh with three pillars, *trigone cerebral,* below whieh we find the plexus ehoroides, whieh marks the inferior surfaee in the form of a lyre. Finally, below we meet with the middle ventriele, at the posterior part of which the *pineal gland* is situated, and also the two pedieles, by whieh this gland is united to the optie layers, the *posterior commissure,* and the *anus,* whieh forms the anterior orifiee of the *aqueduct* of *Sylvius;* in front, the *anterior commissure,* the *vulva,* and the two foramina, that open into the lateral ventrieles. 2dly. On the sides, eaeh hemisphere presents a large eavity (the *lateral ventricles,*) offering to view from before backwards, the *corpora striata,* the *optic thalami,* the *tæniæ semi-circulares,* the *choroid plexuses,* the posterior angles of the *trigone,* the *cornua ammonis;* and, finally, on eaeh side the digital eavity, in whieh we observe the *unciform eminence.*

The brain, similar to the eerebellum, is eomposed of

a grey external or cortical membrane; but it contains, moreover, ganglia of grey matter, in which the elementary fibres increase in bulk previously to their expanding.

From this short description of the brain, we have been able to remark, that the medulla oblongata, such as we have considered it, forms a kind of central focus of the nervous apparatus. In fact, on the one part, it communicates with the brain and cerebellum, which seem to result from its expansion; on the other part, it forms the communications of these lobes with the other parts of the system, by being continued downwards with the spinal marrow. On a level with the great occipital hole, the anterior pyramids cross each other; some authors pretend, that the interlacing of the marrow becomes general in this point.

We have considered the brain as forming a single nervous mass; but *Gall* professes that this organ consists of several groups of particular nervous systems, appropriated to the different moral acts. Most modern physiologists adopt his doctrine.

The mass of the brain presents some varieties, with respect to individuals, sexes, &c. It has been remarked, for instance, that the volume and number of the circumvolutions, are in a direct proportion with the extent of the mental faculties; and

that in females, the brain, comparatively speaking, is smaller, and the cerebellum larger than in man.

The scalp, the bones of the cranium, the dura-mater, the arachnoid, and the pia-mater, are the coverings that protect the brain. This organ receives four large arteries, the two internal carotid and the two vertebral; these vessels ramify to some considerable extent in the pia-mater, previously to entering into the cerebral substance. The portion of venous blood this organ receives, flows into the sinuses, which belong to the dura-mater, from whence this fluid is subsequently poured into the internal jugular veins.

ARTICLE II.

Sect. I. *Of Intellectual Faculties.*

Intellect, understanding, conception, wit, &c. such are the divers generic names applied to the faculties by which man becomes acquainted with, and reasons upon natural agents, and applies them, as occasion may require, either to useful purposes, for to other views. We apply the term *metaphysics*, and to be more particular, *ideology*, to that science which has these faculties in view. Philosophers do not agree as to the number and the proper assignation of the primitive intellectual

faculties. These faculties are first divided into two grand classes: *Locke*, and his school, admitted of a sole principal faculty, from which the others were derived. *Malebranch*, *Hobbes*, *Willis*, *Ch. Bounet*, and *Gall*, acknowledge a plurality of faculties; and as a natural consequence thereof, they ascribe different uses to the different parts of the brain.

The former class of philosophers, however, disagree with respect to which of these faculties is the primitive, as well as the number derived from this first. *Locke* and *Condillac* make it consist in sensation; *Delaromiquiere*, in attention; *Destrutt-Traccy*, in perception. From sensation, *Condillac* draws, attention, comparison, judgment, reflection, imagination, and reasoning. From attention, *Delaromiquiere* deduces comparison and reasoning; *Destrutt-Tracey* pretends, that memory, judgment, and will, are derived from perception.

Ch. Bounet, *Kant*, and *Gall*, have particularly endeavoured to attribute the phenomena of the mind to original faculties, or, to be more explicit, to multiplied functional results. *Kandt* admits of twenty-five forms, or fundamental primitive qualities; *Gall* of twenty-seven, to which *Spurzheim* has added eight more. It should be observed, that amongst these are included, the moral feelings, properly so called, and which shall in their turn come under consideration. It is almost impossible to specify pre-

cisely the number of the fundamental faculties, as some may actually be nothing more than modifications of others. However, it appears from the following considerations, that the plurality of faculties must be admitted.

By sensation, attention, perception, considered, (the first by *Condillac*, the second by *Dela Romiquicre*, the third by *Destrutt-Tracy*,) as generic faculties, from which all others are derived, we can actually explain the operations of the mind; but are we to conclude from this, that there are no particular independent faculties belonging to some distinct apparatus, and concurring to the production of a general one? The faculties of digestion and of sensation explain the phenomena of digestion and of the senses; but we find these general functions to consist of special functions: the former including mastication, insalivation, deglutition, &c.; the latter, of sight, hearing, &c.

Why, in the different series of animals, and at the different stages of life, do we observe the intensity of a faculty, to increase or to sink, and such changes to coincide with those of number, and of form in the parts? Why again are there so many varieties in the disposition and structure of the brain, if there were but one intellectual power?

If these powers are restricted to one single faculty, why does not every individual, who earnestly and assiduously devotes his time to the study of mathema-

tics, of poetry, of music, of the practice of medicine, or to mechanical arts,—why, I say, does not that individual become a *Newton*, an *Homer*, a *Raphael*, a *Lulli*, an *Hippocrates*, a *Vaucanson?*

Why, again, do we see men remarkably ingenious for one faculty, whilst they border upon idiotism in other respects? Why, in short, do we sometimes find, that a faculty is annihilated, and that all others have survived this loss?

It is, then, highly probable that the phenomena of the mind, cannot be attributed to a single primordial faculty. I have used the word probable, because the doctrine of plurality has not in every one of its points been explained in a satisfactory manner; for instance, when we come to reflect on the unity of sensation, of existence, of that notion a being conceives of himself, there ought to be, according to *Georget*, as many self-perceptions, as there are intellectual faculties or feelings. Some author or other has answered (for I do not remember *Gall* ever met this objection,) that there existed a faculty for this feeling in a rational being, a faculty from which all others are derived; but, if this be admitted, from that very moment the latter must consist of nothing more than of dispositions and tendencies.

It appears also extraordinary to see these faculties, reciprocally borrow information from each other, communicate together for the accomplishment of the acts

of the mind, for the performance of which, the simultaneous concordance of several is frequently indispensable, and remain at the same time connected with the sensorial power. But this objection has less weight than the former, when we reflect, that every nerve originates from the spinal marrow and medulla oblongata, the radiating fibres of which expand to form the brain: these questions will be partly resolved as far, at least, as relates to the latter.

We ought not to be surprised, that amongst the twenty-seven primitive faculties of *Gall*, sensation, attention, perception, comparison, judgment, and reasoning, are omitted; these form general attributes, modes of manifestation, common to every faculty of the mind,—common to all moral and instinctive qualities. Such a man, for instance, is gifted with conception, with easy and correct ideas for mathematics, who may be denied any of the faculties, with respect to comparative sagacity, &c. Hence, it follows, that we more easily acquire any knowledge whatever, as the faculties connected therewith are more developed.

Perception, which is the most indispensable condition, required for mental labour, presupposes sensation and attention. By perception, we acquire a notion, a knowledge, an idea of bodies; but this faculty will only convey simple and partial ideas, even when perception is extended to the particular qualities observable in bodies, either partially or collectively consi-

dered. Then, the faculty of comparing shows the analogy of the extended perception, from which concrete, generic, and collective ideas generate. The latter only form abstract ideas, because they are not possessed of their natural type. Comparison may have these ideas in view, as well as the preceding. From these concrete ideas, the parents of science, results a special assiduity to some particular object. The former act of the mind is termed *synthesis*, the latter *analysis*. From comparison naturally results judgment. Finally, we are said to reason, whenever we establish connections between the conclusions, drawn from different comparisons.

Imagination, according to *Condillac*, is the faculty of recalling to mind preconceived notions; thus memory is attached to it. According to *Destrutt-Tracey*, imagination is a sagacity for seizing numerous connections, not only with respect to painting and to music, but, generally speaking, in every art and science.

Memory is that faculty which recals ideas. Memory is active when under the influence of the will; it is passive, when it is independent of that faculty, and the return of ideas is accidental and unknown to us, as it were. In such cases memory is more or less described by the word *remembrance*.

Will is a faculty, a special attribute of oneself, proper to the individual who exercises it, and, according to which, subsequently to some admitted comparison,

an individual feels almost irresistibly inclined or drawn towards a determined object. Concessions to will are attended with a gratifying sensation, resistance to it with the reverse: There frequently exists a tendency to satisfy the activity of a faculty; and, according as that want happens to be more or less pressing, or as it may chance to be counter-balanced by another, the will of gratifying that want is more or less free. It is evident, then, that the power of yielding to, or of resisting the will, is not altogether absolute. Will enjoys a greater sway proportionally as one or several faculties are not allowed to become overruling. In a word, although we are gifted with moral liberty and free-will, the exercising of this faculty becomes more or less difficult, as the intensity of the desire is more or less irresistible.

The sketches we have just drawn with respect to the number, and the determinations of the faculties of the mind, sufficiently prove the difficulty of such analysis. We have seen that some authors refer every thing to a primitive and unique faculty, and disagree amongst themselves with respect to the choice, the order of pre-eminence and of the causality of those that are derived from it. Others refer the intellects to several primitive faculties. The diversity of opinion with respect to the sources from which these eminent functions is derived are not less glaring.

These new senses are by far more precious than our

common sense; the latter have extended the sphere of man within a very limited compass only; the former have enabled him to build cities, to plough the main, to trade with the most distant nations that inhabit the globe, to soar above the clouds, to detect and calculate the courses traced by the immensity of worlds that float in the space, and to admire the harmony of the whole. By the former, again, he has been enabled to invent liberal arts, to give life to canvas and to marble; to depict in the most vivid colours of poetry, the high feats of heroes, the comforts and sweets of a peaceful rural life; finally, it is the intellect that has created and directed the expression of physiognomy, the gestures, the voice, means of communication between contemporaries; moreover, by substantiating ideas, by certain signs or writing, man has been able to communicate with future ages. By that written language he prevents his ideas from becoming evanescent as soon as created, and transmits them to his fellow-creatures, thus insuring the continual and unlimited progress of arts and sciences, as far at least as lays within our power to extend them.

Sect. 2. *Moral Faculties.*

Morals are that part of psychology, by which we analyse affective faculties,—the qualities of the heart,—to speak the language of the world, and draw the

limits within which will is to restrain their use, so as not to exceed those of wisdom, the source of our happiness.

We have seen that ideologists endeavour to refer the intellectual faculties: some to an essential, unique, primordial faculty; others to a more or less considerable number of independent faculties. Well, then, similar diversity of opinion, is observable amongst moralists.

The celebrated *Volney*, and many others, refer them entirely to *self-love;* and as a type of his secondary classifications he has selected, love or pleasure, inclination towards an object, or hatred, pain, or aversion. With respect to their results on society at large, they have been divided into virtuous, vicious, or mixt.

Pinel, considering their effects, has classified them into expansive and oppressive.

Esquirol divides them into primitive, which belong to man as an animal, insulated, such as courage, love and hatred; and into factitious or social, such as vanity, pride, ambition.

Finally, *Alibert* has lately derived them from four primordial laws; namely, from instinct of preservation, from instinct of imitation, instinct of relation, and instinct of reproduction.

Gall, as we said in the preceding chapter, admits of twenty-seven primordial faculties, amongst which he ranks the primitive moral faculties, inclinations, sentiments, or passions; these are, love, affection,

self-defence, carnivorous instinct, love of property, pride, ambition, vanity. The name of affection he retained to characterise the transitory faculties: such as joy, grief, passion, fear, and terror.

If a moral faculty is sufficiently developed, or excited to induce the will to satisfy it, and to create a quick desire, anxiety or suffering is the consequence—hence the word *passion*.

Passions are internal sensations, cerebral sensations, inclinations, wants, comparable in some degree with those of hunger, of thirst, gratifying it may be to the individual to indulge them, as painful will it prove to resist them. But the indulgence is often attended with consequences that prove fatal both to himself and to society at large; on the contrary, if resisted, the act frees the subject from remorse, and is conducive to his peace and his happiness. Comparative sagacity, a notion of what is just, and what is not, and a consciousness of moral liberty, having thus been bestowed on man, he becomes the sole arbiter of his happiness or his misfortune; at least, in the eyes of the wise, who consider man in the abstract, and not at the slave of the prejudices of the world.

Every passion is useful in itself, provided however such passions are conducted and modified by a well regulated mind. It follows, then, that there are no passions exclusively virtuous or exclusively vicious—all are mixt. In like manner to all intellectual acts, pas-

tions become a source of enjoyment and of pleasure to man, if he does not abuse them. The love of offspring, friendship, amorous attachment, are so many elements of happiness.

By the faculties of attachment, man is induced to live in a social state; a most valuable tendency, without which he must unavoidably perish during the course of his long protracted infancy, when we consider that he is denied both offensive and defensive weapons. For, long after having left the parent's breast, he still looks up to his relatives for food, and requires that they may gradually unfold in him those intellec-lectual faculties which at no very distant day are about to make, of so helpless and miserable a being, a man—a lord of the creation.

There are faculties, called human, because they have been bestowed exclusively on man. Such are kindness and religious instinct, or theosophy; the one, which is the source of compassion and liberality, induces men to assist each other, and this faculty evidently becomes the strongest link of social order, and the best calculated for its maintenance. The other leads to the love and worship of God, and is the strongest proof of the existence of a Supreme Being; for what would be the purpose of an instinct or a natural inclination, if that instinct or inclination had no object in view?

ARTICLE III.

Of the Organ of Moral Functions.

The class of intellectual phenomena has just been examined. These phenomena have been viewed independently of their agent—of their organ; it is now proper that this agent should be considered.

Metaphysicians make these phenomena proceed immediately from the soul itself; they consider them as independent of any material instruments. From this theory, the words metaphysics and psychology have originated.

Let the acts of psychology be the immediate results of a physical agent, of an organ, or those of an immaterial principle connected with that organ, their dependance upon the material instrument cannot be called in question. From that very moment, therefore, they return to the class of other functions, and come within the limits of physiology.

Without deciding any thing in respect to the first question, let us endeavour to prove that moral faculties are influenced by physical organization, which is subordinate to them.

An intense exercise of the intellectual faculties is attended with phenomena, at times, even with morbid phenomena, about the head and the viscera.

The alternations of activity and rest, of excitation and langour, in these faculties, sufficiently prove that exercise is submitted to the modification of an organized matter.

Climates, alimentary and pharmaceutic diets, professions, age, sex, a morbid state, &c. have an indisputable influence over the cerebral functions. We daily experience this fact, and merely recite one instance,—Who is not familiar with the results of a small quantity of wine, of coffee, of poison, into the stomach?

If these functions were separate from a material organ, it must be admitted, that their principle varies with each individual, man or animal,—that each is possessed of a soul proper to itself.

The material nature of the instrument of these functions, either mediate or immediate, appears indisputable; if we did not admit of this, these functions could no longer appertain to physiology.

But physiologists are far from agreeing with respect to the specification of the material organ or organs of this function.

No author (within my knowledge at least) has placed the seat of the intellectual faculties elsewhere than in the brain. This is far from being the case with moral faculties. *Plato* distributed them to the viscera. *Bordeu*, *Buffon*, *Cabanis*, &c. place them externally to the brain, in the thoracic and abdominal

viscera; *Bichat* asserts, that they reside in the organic and ganglionic nerves; these authors chiefly ground themselves on the following arguments, namely, that the effects of passions and affections are felt about the viscera, that both language and gestures concur in attributing to these organs the sensation of these functions. Do we see moral faculties proportioned to the development, and the excitation of these viscera? I do not believe (says *Georget*, in his physiology of the nervous system) this to be the case with ruminating animals, possessed of four stomachs, of voluminous liver, lungs, and heart. Do we observe any change in the faculties of those labouring under an affection of the heart and liver? Moreover, according to some, these phenomena frequently manifest their effects in different viscera, and sometimes even, over the whole economy. Thus, in terror, there may at the same time exist cerebral disturbance, palpitation of the heart and icterus. The hair has been known to become white suddenly, and the complexion swarthy. *Rostan* mentions two cases of this nature. Finally, the intellectual phenomena, residing in the brain, may in the same manner cause similar disturbances in the viscera. *Tissot*, in his treatise, mentions numerous instances of this kind. But this doctrine ought to be entirely expunged; for, if we admit with *Bichat*, the irresistibility of the motions of passions, an irresistibility which he compares with that of convulsions when a splinter of bone has penetrated into the sub-

stance of the brain, we are compelled to deny the existence of free will, and to suppose that passions do not admit of being softened and regulated by education.

Moral, as well as intellectual faculties, then reside in the brain. This organ is the primum mobile.

This being granted, is the action of the whole of the encephalous mass required for the performing of psychologic functions? Does one of its parts suffice? Or, again, has each of these faculties a special part allotted to its production? Such are the three most difficult propositions in psychology.

The first is untenable. Most certainly distinct portions of the brain preside over sensations and voluntary motions; functions which are of an entirely different order.

The second has been exploded. Every body knows that *Descartes* had placed the seat of the soul in the pineal gland; others have pointed out the corpus callosum as its organ, &c.

The third proposition was long since brought forward: at first, most physiologists admitted of two orders of fundamental operations, understanding and will, intelligence and sentiment, &c. implicitly acknowledging a plurality of organs. The Arabians, said *Adelon*, place *common sense* in the first ventricle; *imagination* in the second; *judgment* in the third; memory in the fourth. As far back as the thirteenth century, a bishop of Ratisbonne, *Albert the Great*, as-

serted in a publication, that the psychologic faculties resided in the different ventricles. *Willis* clearly expressed that perception had its seat in the corpora-striata, memory and imagination, in the centrum ovale reflexion, in the striated body; and the principle of motions in the cerebellum. *Bonnet*, *Cuvier*, and *Soemmering*, incline to the belief of a plurality of organs.

Gall has particularly insisted on this plurality of organs; this followed as an immediate consequence of the admission of a plurality of primitive faculties. The facts and arguments in support of this first point of his doctrine, and which have already been mentioned, militate *a priori* for the admission of this second point. These proofs are drawn, 1st, From the comparison already made between understanding and digestion, or sensation in general.

2dly. From the development of such a faculty, coinciding with the development of a particular part of the brain in the different series of animals, and at the different stages of life.

3dly. From the predominance of one faculty over the remainder.

4thly. From the vocation of men in accordance with the predominance.

5thly. From their aptitude in its performance.

6thly. From the power of suspending mental fatigue, of procuring rest even by proceeding from the exercise of one faculty to that of another.

7thly. From monomania, idiotism, or partial insanity.

8thly. From the injury sustained by one point of the brain being constantly followed by the modification of a faculty, &c.—(*Vide Gall's Works.*)

But, it has been objected, that we constantly have instances of effusions of blood, of local softenings, circumscribed, without injury to any faculty in particular, but on the contrary, attended with a general cerebral disturbance. When we recollect, says *Georget*, that the different parts of the brain are lodged, and contained within a cavity that does not admit of the slightest displacement, it will be easily conceived that sympathy and pressure must unavoidably bring on in such cases general injury of the organ. To those who inquire how it happens that the brain, which is composed of similar substances in all its different parts, performs different functions; in answer, we shall mention the nerves of the senses, and those intended for locomotion, which, although apparently possessed of a similar structure, are intended for entirely different uses.

Notwithstanding, that the plurality of organs is still a matter of dispute, it is still more substantially proved than their assignation as the agents for such or such a faculty.

The experiments of *Floureus*, on the brain of animals, have proved no more than, that out of the

hemispheres and the cerebellum, these organs would looked for in vain. In fact, it is in these organs, that *Gall* has placed them. By laying down facts, minutely observed, but not very numerous, this author feels himself authorised in assigning to the occipital region the moral faculties, and to the frontal region the intellectual faculties. In studying the methods of ascertaining the moral faculties, we shall find that he has gone very far.

Very recently, my colleagues, *Pinel*, *Grandchamp* and *Foville*, Internes de la Salpetiere, have maintained that the cortical substance is exclusively the part productive of moral faculties, the medullary portions being intrusted with motions. Although this proportion is already supported by a few facts, yet it still requires numerous and attentive researches for its complete demonstration.

ARTICLE IV.

Of the Sources and Mechanism of the Cerebral Functions.

The idea, the knowledge of external objects, without which the brain could not fully exercise its intellectual operations, is transmitted to this organ by the apparatus of the senses. This proposition was proclaimed by *Aristotle* in his celebrated axion: *Nihil est in intellectu quin prius fuerit in sensu.* *Plato*, on

the contrary, supposes the notions, with respect to the nature of bodies, to be innate. According to this philosopher, the essence, the pattern, the image of bodies is preconceived in the mind, these images may remain there unknown to this faculty; when they come to be perceived, it is only from a kind of remembrance, occasioned by these bodies. *Plato*, then, considers these types as being almost independent of the mind. *Descartes* has gone further still: he pretends they are the very ideas of our intellects.

From the doctrine of *Plato* is derived that of idealists, or nominals, according to whom the objects are perceived by the senses, in consequence only of the preconceived image. The doctrine of *Pyrrhon* is another consequence of that of *Plato*. This philosopher, considering the senses as deceptive, views every thing as an illusion; and he goes so far as even to doubt of motion, and of his own existence. Most undoubtedly, we only know objects in ourselves, and by ourselves; we are unacquainted with the essence of their matter. Again, animals, having their senses and brains differently organized than ours, must have a different idea of external objects. This even may, in some degree, be the case with different men. The senses, doubtless, are nothing more than the agents of our intellects; but their correctness should not for all that be doubted, when confirmed both by individual and general experience.

The doctrine of *Aristotle* has since been adopted and maintained by *Bacon, Locke,* and *Condillac.* They compare man, in the first stage of life, to a tabula rasa, on which, that only which is grasped by sensation leaves an impression. There are, however, numerous, sensations, which do not appear to be conveyed to the mind through the medium of the external senses.

Are the numerous modifications of the mind proceeding from age, sex, and the hygienic agents, &c., consequences of the harmonic modifications of our senses? Is it through the medium of the senses that the newly-born infant seizes and sucks the nipple, that a young kid selects the cytisus, amongst other plants? Is it by the senses that we shall be able to explain the origin of the new inclinations, which manifest themselves at the age of puberty,—the mobility and eccentricity of the mind during menstruation and pregnancy?

Cabanis was one of the first who drew our attention to these facts; and he attributes their origin to motions in the internal organs, to internal sensations, which, being unknown to the brain, or to the individual, do not the less create in him new ideas.

But we can perfectly explain, by the modifications of the brain, primitively occuring under the fore-mentioned circumstances, the modifications taking place in the intellectual acts. In fact, the state of our in-

tellects is not strictly subordinate to the perfection, or accuracy of our senses; the senses and the intellectual acts are linked together, and are indispensible to each other: theformer make us acquainted with the world, and supply the mind with materials indispensible for its labour. But the perfection of these acts depends upon the development of the innate dispositions and faculties. The sensations of the exterior world are, in truth, the materials upon which the functions of the mind exercise themselves; in some measure they are to the brain, what food is to the stomach; but they do not exclusively influence these functions. The new-born infant can be compared to a tabula rasa, inasmuch only that he is void of impressions. The results so variously diversified, observable in these functions in different subjects, essentially proceed from the modifications in the cerebral organization, our dispositions are born with us, sensations merely procure opportunities for manifestation. This explains why *Leibnitz* added to the axiom, *nihil est in intellectu, &c.* these words, *nisi ipse intellectus.*

Bonnet, *Kant*, and *Gall*, are the philosophers who have settled by the most substantial and the most numerous proofs, the doctrine of innate dispositions. Not only do they attach to it the intellectual faculties, but moreover the passions, and even what *Gall* terms affections; for, observes this author, if man be susceptible of joy, of dissatisfaction, of pleasure, of grief,

of terror, of shame, it is because there are things which, by their nature ought to be loved, detected, or dreaded, &c.; every thing within us is calculated upon the exterior world.

ARTICLE V.

Circumstances which modify the Brain and its Functions.

After the research and determination of the organ of the physiological functions, the study of the defects of organizations, and the modifications this organ undergoes under certain circumstances, with respect to ages, sexes, temperaments, or constitutions, certain hygienic agents, such as climate, aliment, profession, education, and civilization, naturally present themselves to our conideration.

Idiots, in general, have the brain small and imperfect, especially in the frontal region; and in some rare cases, in which the conformation does not sensisibly differ from that of other men, idiotism may be explained by the absence of memory, without which ideas cannot be retained, and without which we can neither compare nor reason.

It is no longer questioned, that the brain may be idiopathically or sympathetically altered in insanity, and in febrile delirium, and that consecutively to these alterations it becomes modified in its functions.

During the fœtal life, the senses are precluded from external sensations; but the brain may be accessible to internal morbid sensations, as grief, from which may result determinations which manifest themselves by motions.

Immediately after birth, touch already existing, the other senses are developed in the following order: taste, hearing, sight, smell, which in a few weeks attain perfection. The brain progressively grows; according to *Gall*, the cerebellum, which is the seat of physical love, takes its growth, and comes into action towards puberty—an epoch at which this passion develops itself. The brain acquires the full extent of its growth only towards the age of twenty or thirty, and then all the intellectual and affective functions are at their zenith. Then it is that the qualities of the mind shine to their utmost advantage, and those of the heart are more than ever expanded. The brain maintains itself in this state for some years longer, but it soon partakes of the decline of the other organs.

The experience of aged subjects being more considerable than that of young men, their judgment too, being less influenced by passions, they are better calculated to give advice, to direct, and to govern. This is, in fact, a privilege, which has been granted to old age from time immemorial. In decrepitude, the sensations are benumbed, memory is lost, even judgment decays, and resembles more what it was in infancy.

The brain in the female, in general, presents a volume and development of parts, differing from those in man. In the latter, the intellectual faculties predominate, and the feelings in the former. The female feels more, she thinks less. The instinct of love, or attachment, particularly characterizes the fair sex. It is her finest attribute; it is that which renders her so deeply interesting to the civilized world. She consoles herself in the bosom of her family; having no share in the sciences, none in the administration of the affairs of the world, she there seeks and finds compensation for the humiliations and sorrows with which she is too often overwhelmned even by the master she has received from nature, and whom her own heart probably has selected.

The brain is the sole organ of moral affections; it is the only one whose modifications are immediately followed by those of the intellects. In this organ reside the organic fundamental conditions of the mind. If at times the brain become influenced by the other organs, it is accidental, momentary, and by sympathy; and yet we meet with physiologists, who admit of no other sympathetic influence than those from diseased organs; they deny the possibility of those of healthy parts, or, otherwise speaking, the doctrine of temperaments. According to these men, a sound organ can produce no very remarkable change in its organ-

ism—cannot destroy the harmony primitively constituted; the organs (let us suppose them all in an healthy state) exist, isolated from each other; if, however, says *Georget*, we except the brain, they merely exercise a limited influence over the fellow organ of the respective functions. If we do frequently witness the muscles, the digestive viscera assumes an increase exceeding that of the other organs, this increase will be found concomitant with the weakness of the brain; and let it be remarked, that this latter is primordial. In fact, it is because the brain is unshaken, not wearied with intense meditation, with strong passions, that this predominence could have taken place.

These groups of characters, which the abettors of the doctrine of temperaments attributed to the pre-eminence of the vascular system, of the bilious, &c. we do actually sometimes meet with; but, in such cases, we should look for the cause, not in the organs of circulation, or in the biliary organs, which in the healthy state, can individually have but little influence over organization in general; but we should refer to the brain which keeps up intimate connections between all the parts of the machinery. Thus, in infants, in aged subjects, in idiots, and in the insane, we can account for the deficiency of temperament, by the want of energy in the brain; we can also comprehend why the temperament in females, who are

not subject to vapours, is so weak; and why, on the contrary, there are irritable individuals, whose passions are strong and intense? Why the literati and the studious, habitually devoted to deep meditation, are, as it were, stamped with a common seal, are of a spare habit, their muscular and digestive systems being remarkably reduced. Finally, *Zimmerman* tha celebrated philosopher, has remarked, in several passages of his works, quoted by *Georget*, that the characters of temperaments are owing to the brain, and *Tissot*, positively tells us, that that eminent author intended to prove that the different temperaments of individuals and of nations, resided in the nervous system.

The state of the atmosphere, and of the country, which differences constitute those of climates, are the most powerful modifying agents of the moral man. Air, the chemical analysis of which, as is proved by experiments, is the same in every point of the globe, is altered only by becoming impregnated with miasmata; and by the different degrees of density, owing to cold or heat, it also becomes influential.

The disposition of the soil, with the nature of its productions, modify the moral character of its inhabitants. These circumstances naturally lead to the cultivation of the sciences relating thereto, and inspire men with particular tastes. We are acquainted with the kind of life, peculiar to the inhabitants of low countries, and with that of the people of hilly coun-

tries, as also with that of such as inhabit the coast.

The productions of the mind are marked, if I may be allowed the expression, with a kind of climatic stamp. Only compare the poetry, written under the inspiration of the radiant sky, and in the romantic scenery of the East, with that which has originated amidst the fogs and barren tracks of the Scandinavian soil. The imagination, as expressed in the language of the inhabitants of the East, is as ardent as their scorching sun. That of men, approaching the polar circles, is damped, as it were, by the everlasting ice of those frigid regions.

In the human races and varieties, the modifications of the moral properties have followed those of the physical. It is duly ascertained, that the human species is but one; and that, similar to a transplanted tree, it has assumed different forms in the divers regions of the globe. The influence of climate over the moral faculties in undeniable.

To climates, special productions are referable; so that the nature of the aliment, another modifying cause, both as regards moral and physical properties, is partly subordinate to the climate. Its effects are most striking. According as man uses animal food, stimulating substances, ardent liquors; or as he may use fish, vegetables, and aqueous drinks, the functions will be, generally speaking, active or languid.

When, by a succession of ages, the mass of a nation

have been stamped with these modifications, such nation retains them, and transmits them to posterity; hence results the moral type of races, of nations.

Exercise is conducive to the development—to the strengthening of the organs of our economy. To practise the intellectual organ, is no less obligatory and useful to man, than using the instruments of his other functions; with this exception only, that he should exercise indefinitely the intellectual faculties, and carry them to the highest possible extent. With respect to the moral faculties, he ought also to cultivate them, inasmuch as they may be advantageous to the individual himself and to society at large, and check what might be disadvantageous. Moral education is that science which has in view the safest means of attaining this double end. It naturally divides itself into two branches: the one has the mind for its object, the other the passions and affections.

Life is too short to admit of cultivation of every faculty, we ought consequently to select that for the development of which the predispositions are the most striking; in this consists the great talent of the professor. Besides, time is nearly lost when we compel a child to study an object, for the acquirement of which the brain shows little or no disposition. Education also should be different for both sexes. We should endeavour particularly to develop affective faculties in the female, and not those of comparative

sagacity, of mathematics, &c. The repetition of similar acts, or practice, tends to develop the organ that executes them; hence it is easily conceived, that the more the brain is exercised in the various professions of civil life, the better it will be fitted for the performance of its functions; and, according to the end these professions have in view, as a faculty is more frequently brought to act than the others, so it will acquire a marked pre-eminence. It is a common, but true saying, that it is by doing a thing often we are taught to do it well.

The different degrees of civilization, and religion also, have an influence over the functions of the brain; but considering the narrow limits of this work, we shall dwell no longer on this subject.

ARTICLE VI.

Of the Means of Appreciating the Mode and Extent of Moral Faculties.

The exercise of a function is so much easier and more regular as the organ devoted to it is better developed, and, at the same time, the more stimulated and excited.

Such are the elements according to which the extent and energy of a function may be calculated. We perceive that the first, or the material bulk of the

organ is the only one appreciable; it is to be enabled to decide *a priori* of this development that the different methods of divination for the intellectual faculties have been established. There exists, however, a mode which does not rest upon these ideas: it is that of *Lavater*, who seeks in the expression of the features, the extent of the intellectual and affective faculties. Most undoubtedly the features bear the stamp of passions, of genius, of idiotism, and imbecility; and, on that account, are called the reflectors of the *soul*. The brain gives an expressio. of its acts through the nerves of the eye, and through those which animate the muscles of the nose, and of the mouth. *Magendie* and *C. Bell* have proved, that expression essentially depends upon the facial nerve. The repetition of the same intellectual operations draws along with it a peculiar expression of the face, and, in progress of time, there may result from this a permament physiognomy. But *Lavater* has exaggerated his system, and undoubtedly he went too far, when he inferred natural dispositions from the original conformation of the face.

We have seen the doctrine of temperaments contested. We have proved how little the brain is influenced by healthy organs. It would be contradictory then, and very unsafe, to take manifestation of these pretended temperaments for those of intellect and of passions.

It is in the dimensions only of the mass of the brain, that most authors have sought, and that with reason, for the extent of the psychological functions.

Aristotle had already considered the absolute development of the brain, as that of the intellects; and the volume of the brain, relatively to that of the body, was subsequently laid down as a rule; finally, others, at the head of whom we find *Soemmering*, think they have ascertained the measurement by comparing the cerebral mass with that of the medulla oblongata, or with that of the nerves. These modes, difficult in their application, cannot be admitted, owing to the numerous exceptions pointed out by comparative anatomy.

Every body is acquainted with the angles by which *Camper* and *Daubenton* pretended to measure the organ of moral functions. *Camper* applied the angle to the forehead. He formed it by drawing a horizontal line from the level of the occipital foramen to the superior incisors, on a level with which teeth, this line joined another ascending one, vertical, and parallel with the face and forehead. *Daubenton* drew a line from the inferior part of the condyles, and another vertical line from these condyles to the sinciput.

The facial angle of *Camper*, and the occipital of *Daubenton* (these angles have taken their denomination from the place of their application) only give the degree

of opening, the proportion of the brain towards the forehead or the occiput; they give neither the height nor the width of the organ; there are particular circumstances of volume of the brain which cause the opening of these angles to vary: Such is, for instance, the thickness of the bones (and this is particularly applicable to that of *Camper*,) the projection of the jaws, and of the frontal sinuses. Besides, admitting even these methods to be correct, they could only serve to measure, respectively, the first the anterior parts, the second the posterior. According to *Gall*, and other physiologists, these parts are respectively intended: the one for the intellectual faculties, the other for the moral sentiments.

The celebrated *Cuvier* proposes a safe method to judge of the extent of the brain; but, unfortunately, it is not practicable in the living subject. He proposes to compare the extent and figure of the area of the cranium and the face. To this effect he saws the skull and face vertically over the median line. This area has been found longer in the European, and gradually to diminish in the Calmuk, the Negro, &c.

Gall, in a celebrated system, laying aside the consideration of the whole mass of the brain, has endeavoured to judge, by the extent of surface and of the projection of the different departments which impart tendency or aptitude for such or such a faculty; hence,

the names of craniology, cranioscopy, which he has adopted.

By admitting as indisputable the demonstration of the plurality of organs, and of the assignation of their seats, the idea is natural, because the skull moulds itself upon the brain, at least it does as the latter has not attained its full development. But, when in old age, the volume of the brain undergoes modifications, it is upon the internal table only they are perceived, and not on the external. This art then is not applicable to the aged. Next, the irregularity of the muscular and osseous projections must render its application excessively difficult. Thus it is, that of the three fundamental points of his doctrine it is this upon which our philosopher has insisted the least. However, he has produced so many facts with respect to the following propositions that a number of persons admit of them:

1st. The skull of idiots is chiefly depressed towards the anterior parts.

2d. That of the female is more developed towards the occipital, the seat of moral faculties, than towards the frontal, which is the seat of the intellectual functions.

3dly. Most men of genius have an enormous forehead. In viewing the statues of antiquity, we are induced to believe that this fact had not escaped the sagacious observation of the ancients. But in attempt-

ing to enter into the details of this science, *Gall* acknowledges his incapability, and its failure in many cases ; in this respect, the ideas of this grand observer have been much exaggerated, and most bitterly and unjustly criticised.

CHAP. III.

OF LOCOMOTION, OR OF VOLUNTARY MOTION.

The name of locomotion is given to that function by which man, in consequence of a determination of the will, moves his body in part or altogether, so as to establish connections with the surrounding beings.

ARTICLE I.

Apparatus of Locomotion.

In man, it is composed of passive organs (the bones,) and of active organs (the muscular and nervous apparatus.)

Of Bones.—This name has been given to an assemblage of compact organs, united together by ligaments which assist in forming a whole, giving to the body, whose frame work they form, shape and solidity. They

are divided, in consequence of their forms, into flat bones, particularly intended to form the splanchnic cavities, into long and into short bones, met with in the limbs. They present for consideration: 1st. Eminences, which are distinguished according to their uses, into *articulatory*, and into eminences of *insertion*, of *reflexion*, and of *impression;* 2dly. Into cavities, also divided into *articulary*, and cavities of impression, of insertion, of reception, &c.

Bones are composed of an areolar organic tissue, in which an earthy salt has been deposited; they receive arteries, veins, and nerves. They are covered externally by a fibrous membrane, called the *periosteum.* The interior of these organs is filled with porosities, and is hollowed canal-like. This canal is lined with a cellulo-vascular membrane, that contains the medullary fat.

The parts at which bones reunite, assume the name of *articulations. Soemmering*, however, grants that name only to those which perform motions. They are also divided—1st. Into *synarthrosis*, which include the sutures and gomphosis; 2dly. In *amphiarthrosis*, when the bones are reunited by a fibro-cartilaginous substance; 3dly. In *Diarthrosis*, which comprehends *enarthrosis, arthrodia, planiform diarthrosis, ginglymus*, and *trochoid.* The articulatory surfaces are in general incrustated with a cartilage, and sometimes are separated by fibro-cartilage, which are

invariably secured in their respective connections by fibrous ligaments. Generally also, a synovial membrane lines the interior of the articulation, and facilitates the motions.

The reunion of all the bones forms a mobile frame work, that gives support to all other parts of man. We observe in it, with respect to locomotion, the head which is articulated in a moveable manner on a long osseous shaft, composed of a series of small bones, united together by very strong fibro-cartilage, which admits only of limited motion; but which motions, however, becoming multiplied by each articulation, form a very extensive motion in the whole. This column, which is called the *spine*, is the principal lever of the body. It supports, in front, the capacious splanchnic cavities, and transmits this weight to the inferior limbs, at the same time that it contains within its canal the most important part of the nervous system of locomotion. The inferior limbs are a kind of articulated columns, commissioned to sustain the weight of the body; the superior limbs, on the contrary, are organs of prehension: they are levers, interrupted by articulations, which allow of motions, greatly extended and multifarious.

Of Muscles.—Muscles are all the parts of the animal which perform contraction, from which motions originate; they consist of fasciculi more or less voluminous, red, inserted by their extremities to the sur-

faees of bones, to which, they impart motions. We are already aware that the museular fibre is one of the elementary fibres, let us now see what has been said of its intimate nature. *Heister, Cowper, Willis, Hamberger, &c.* are of opinion that this fibre is hollow; some pretend it eontains a spongious substanee, others that it is identical with the nerves; others, again, eall it compact, and this last opinion has prevailed.

It is from a re-union of these elementary fibres that the muscular fascieuli result, the power of whieh is in proportion to their respective volume and length. Their extremities terminate in tendons or aponeuroses; they are never inserted in bones, without the intermedium of these parts:—museles reeeive a eonsiderable portion of vessels and nerves.

Of Nerves.—The nervous system, whieh animates the muscles, ineludes the spinal marrow, and the nerves, that braneh off from this eord; and, moreover, aeeording to some authors, the cerebellum, whieh is said by *Flourens*, to be the regulator or governing organ of motions; finally, the brain itself, by the fact that it regulates every voluntary aet, has a share in locomotion, as has been demonstrated by a series of experiments, and a number of morbid alterations. But it appears that it is the determination which partieularly falls to its lot. All these parts have been viewed in treating of sensations.

Of Muscular Contraction in General.

From the different ideas, physiologists have created of the nature of the muscular fibre, they have invented different hypothesis respecting the *essence* of this contraction. Thus, those who have considered this fibre as tubular, have concluded that its contraction is solicited by its being filled with blood, or nervous spirit, or by a kind of effervescence developed in its cavity. *Haller* professed that contraction was a property, inherent in muscles. The ancients explained that phenomenon, by a kind of mechanical drawing of the muscular fibre effected by the nerves. It is well known that the researches of *Dumas* and *Prevost*, tend to this opinion. From this division of opinions, we may conclude that the nature of contraction is still hidden from us. Let us then restrict ourselves to what is demonstrated by observation. When a muscle contracts, the following phenomena are observable: 1st. Its extremities draw nearer, consequently the fibres are more or less shortened; 2dly. The muscle very frequently acquires considerable hardness and enormous strength; 3dly. It is supposed to increase in bulk in spite of the contradictory experiments of *Borelli*, *Glisson*, &c.; 4thly. The intensity of contraction varies at will, passion increases its energy; 5thly. The bones passively obey contractions in the directions al-

lowed by the articulations; 6thly. Finally, the muscle grows weary, it requires rest, it relaxes. Some authors, however, consider this state of relaxation as an active state; but we are aware that this frequently occurs even in spite of the will; 7thly. We might also add, as a positive fact, that the healthy state of arteries and nerves, which enter a muscle, is an indispensible condition for their action.

ARTICLE II.

Of Position.

Position is that function, passive or active, by which the different parts of the body are maintained in a fixed attitude. The position is *passive* when the body is stretched all its length on the earth; it is *active*, when the trunk is supported by columns, the limbs.

1st. *Biped Position.*—Man does not form a sole lever from head to foot: he presents a great number of joints which incessantly tend to deny each other mutual assistance. The *head*, fixed on the vertebral column, presents a lever of the first order; the main arm of which being directed forward, the head has a tendency to flex in that direction, but the numerous muscles of the posterior part of the neck, and the posterior cervical ligament, maintain the equilibrium. *Spine:* The

superior limbs, the enormous weight of the organs contained within the chest and the abdomen, finally, the head itself, weigh upon the vertebral column, and would unavoidably draw it forward, if to the solidity of its organization it did not unite numerous and powerful muscles, extended along its posterior part, to counterbalance the weight under which it would otherwise sink. The inferior vertebræ are first fixed upon the sacrum, subsequently they successively form a point of resistance for the superior; each of them represents a lever of the first order, the power of which is in the organs that tend to draw it forwards, the point of rest in the inter-articulatory fibro-cartilages, and the resistance, in the muscles, which are inserted in their apophyses, and which counterbalance the weight of the anterior parts. By this mechanism, the spine is transformed into a single lever of the third order, which transmits the whole weight of the superior parts, through the medium of the sacrum, to the pelvis, with which it is articulated in such a manner as not to admit of motion; so that we are perfectly justified in considering it as a base added to the grand lever of the spine.

The trunk stands in equilibrium upon two rounded pivots (*the heads of the femurs;*) but that equilibrium proceeds from a combination of several powers; on the one hand, the inclined position of the pelvis, and the weight of the superior parts, renew the tendency

to falling forwards; but, on the other hand, the large muscles of the buttocks, and the flexors of the leg, counterbalance this tendency.

The femur transmits to the tibia all the weight it has just received ; the articulation of these two bones, although a solid one, would be too narrow to form a base capable of maintaining the equilibrium, and the thigh would flex over the leg, if this effect were not prevented by the extensor muscles of the latter. Here again the muscles act as a lever of the third order, and in an order nearly parallel with the bones; however, the patella, in some degree, remedies this inconvenience.

The weight of the body falls perpendicularly upon the tibio-tarsal articulation, which is narrow and mobile, thus it again inclines to fall forwards; this time, it is the muscles of the calf, to which the body is indebted for retaining the vertical position.

Finally, the foot transmits to the earth the whole weight of the body. Its anatomical structure and width are perfectly calculated to insure the solidity of the standing position, in which this organ, indeed, takes an active part; it presents, in fact, a slight concavity from before backward, and it contracts to grasp the soil, as it were.

Such are the muscular actions which keep the body in a vertical position; they might equally be considered from below upwards; and perhaps then the mu-

tual assistance they borrow from each other might be still better appreciated.

It is well known in mechanics, that a body retains the erect position, whenever the part by which it rests upon the soil (*base of sustension,*) is sufficiently extended for the vertical line to fall within the space circumscribed by this base, and that the erect position is so much firmer as the latter is wider. Well, then, this law is applicable to man. We remark in him a series of bases, which gradually widen as they descend lower, so as to represent a kind of pyramid; but a very remarkable fact is, that these bases extend the more in the very direction he is most inclined to fall, which will be easily ascertained by comparing the connections of situation and proportion existing between the *atlas, the sacrum, the interval between the two cotyloidian cavities, that of the two thigh bones, and that which circumscribes the feet.* These bases, in fact, become more and more anterior and capacious.

In spite of what some philosophers have said, standing is the natural position of man. The horizontal situation of the occipital condyles, the weakness of the muscles of the neck and cervical ligament, the direction of the face, of the eyes, of the nostrils; aliment which would drop from the mouth; the curvatures of the spine, by which the centre of gravity is extended in the erect position; the length of the inferior extre-

mities, &c.; the whole organization, in short, concur to prove this assertion.

Soliped Position.—This position is very difficult and not firm, for this reason, that the base of sustension is very narrow, the trunk inclines sideways, then the muscles of the corresponding hip display their utmost energy.

Kneeling.—The body rests on the patellas; the base of sustension is extended backwards, and none exists in front, which accounts for the fatigue with which the extensor muscles of the trunk are soon overcome.

Sitting.—The weight of the body is transmitted to the pelvis. This position is very fatiguing to the abdominal muscles, when sitting on the soil, where there is no back support; it is less so when accommodated with an elevated seat, in which case the body is less inclined to fall backwards; finally, when the seat is provided with a back support, it is the position man prefers, as it is almost passive.

When this position is attended with flexion of the legs and thighs, and that the hands are crossed over these parts, it assumes the term of squatting (*accroupie.*)

Standing upon the Head can be effected with the assistance of the arms only, which in this case circumscribe an extensive base of sustension.

Recumbent Position requires no muscular exertion.

Walking.—Walking is the common act of progres-

sion; to effect this progression, each of our inferior limbs is alternately passed before the other, from which motion results the *step;* a succession of the latter constitutes walk, the mechanism of which is as follows: Man slightly inclines forward on one of the limbs; next, he successively flexes the articulations of the other; the foot in this act, lifted from the soil, is then carried forward, and applied to the soil, again beginning by the heel: The body soon inclines upon the limb that has in these motions become anterior; from that moment the leg which was left behind leaves the soil, its articulations become flexed, and by motions similar to the preceding, it becomes in turn the anterior. The pelvis, at the same time, performs alternate motions of rotation upon the heads of the thigh bones, a succession of which forms actual *zig-zags*, particularly remarkable in the well formed female, on account of the width of her pelvis.

Walking backwards is executed nearly in the same manner, with this exception, that the leg being carried backwards, the toe first touches the soil.

In ascending, the limb which is carried forwards, draws upon itself the body against the order of gravitation; to effect this, the anterior muscles of the thigh strongly contract; but this motion is generally assisted when inclining forward, by the action of the anterior muscles of the trunk, which in this act compress the chest, and hence occasion accelerated breathing.

In descending, the flexion of the limbs is less extensive, the feet are in some measure drawn forward by gravitation; but the fall of the body forward would be unavoidable, without the continual contraction of the posterior muscles of the trunk, which renders this mode of progression fatiguing.

In these different modes of progression, the centre of gravity is alternately conveyed from one limb to another; the arms fill the officc of levers.

Leaping.—The body of the human subject admits of being propelled, after the manner of passive projectiles, by the sudden, abrupt, and convulsive extension, as it were, of most part of the articulations, subsequently to these being flexed. The head, the trunk, the pelvis, the thighs, and the legs, become flexed. Suddenly, the extensor muscles violently contract, particularly those of the inferior limbs, and produce an effort of projcction, that lifts the body from the soil, in a perpendicular direction. If in effecting this instantaneous straightening of the joints, we incline the body in any direction whatever, it not only rises, but describes a curve, by which it is conveyed to a distance. This kind of leaping is generally preceded by a short run. *Borelli* compares the leap of a man to a distending spring. *Barther* is of a contrary opinion; he says, that the soil has nothing to do with the production of this phenomenon. However,

we easily rise from an elastic soil, and can leap to no great extent on loose sand, &c.

Of Running.—Running is considered by physiologists as a series of alternate leaps; and most of them regard it as the result of a combination of the two preceding exercises, *walking* and *jumping*. This, in fact, is what its mechanism is about to prove. First, the body is gently flexed, one of the limbs is suddenly carried forward, before it reaches the ground; the other abruptly stretches its articulations, in consequence of which, it imparts a motion of projection to the body. Now the limb that has been carried forward reaches the ground, and receives the whole weight of the body, it immediately leaves the soil by a mechanism similar to the preceding, that is to say, by contracting abruptly also, to throw the line of gravity on the other leg.

Thus, independently of steps, similar to those which constitute walking, we meet, in running, with the motion of projection, during which the centre of gravity moves, suspended in the air. Most part of the muscles, which fix the lumbar region and the *pelvis*, take their point of rest upon the chest, from whence proceeds the shortness and acceleration of respiration.

Swimming.—This mode of progression is not so natural to man as the preceding; his physical organization has been calculated upon no hydrostatic law, his specific gravity generally, exceeds that of water. Thus,

in swimming, the whole science consists in multiplying the surface of the body by extensive motions, so as to displace a greater volume of liquid.

The body extended on its anterior part, advances on the surface of the water in the following manner: The hands brought together, in front of the chest, form a point; the thighs and legs, previously flexed, abruptly extend, striking the water backwards, already impart a slight motion of progression to the body. At the same time, the superior extremities extend, striking the water in the form of paddles, and the legs are brought together. Next, whilst progression takes place, the limbs flex again, to be returned to their primitive position, when the superior limbs describe a circle which propel the element under the trunk, and thus it is raised more or less above water. The spinal muscles are in a continual state of contraction to fix the vertebral column, and raise the head. Swimming on the back hardly requires any exertion, with this exception, that the anterior muscles of the trunk are slightly contracted.

ARTICLE III.

Mechanism of the Superior Limbs.

The superior limbs have been very properly considered as organs of prehension. To some considera-

ble degree of strength, astonishing mobility is united, either in the shoulder, the motions of which are excessively varied, or in the fore arm, where the two bones move one upon the other, by the help of great muscles, or in the hand, the wonderful mobility of which is so subservient to the arts. Where now is the man, who, on considering the delicacy of the motions of the fingers, in writing, drawing, and music, will be obstinate enough to contend that these organs were intended for treading?

In the acts of *pushing*, *drawing*, *grasping*, *squeezing*, *carrying*, &c. the superior limbs are more or less active. But to describe each of these motions in particular, would exceed the limits of this work. The information we have just acquired respecting animal mechanism, will sufficiently compensate for silence in this respect.

CHAP. IV.

OF EXPRESSIONS.

Man, above all other animals, enjoys the faculty of expressing his sentiments, of displaying his passions: the means of expressing them consist of gestures and speech

ARTICLE I.

Gestures.

This name has been given to the silent expression of our feelings. The face is the principal seat of the mode of expression, the numerous muscles, and the particular organs it is composed of, render it perfectly fit for this use. The almost unlimited variety of motions of the forehead, of the eyes, eye-brows, lips, &c. will suffice to keep up the longest conversations, and to express the most tender feelings. The face, in

a word, according to the common saying, is *the mirror of the soul:* gait, attitudes, the motions of the limbs, the state of respiration, are so many phenomena, which betray our passions.

From these divers gestures arises a particular language, called involuntary ; it is composed, as we see, of a great number of phenomena, which are irresistibly developed, and which disclose the state of the heart and of the mind. Are not *laughter, smiling, crying, sobbing, sighing, gaping, looking, silence,* &c. &c. expressive of merriment, sorrow, love, ennui, terror, hatred, despair, jealousy, &c. &c.

In vain do we endeavour to conceal these phenomena, they break forth in spite of us, but in different degrees, regulated by the state of our sensibility. Their cause is unknown. *Gall* is of opinion, that their production is somewhat connected with the state of the organ, wherein the sensation that produces them unfolds itself.

In some cases, gestures are voluntary: they generally are attended with speech, and then form a part of conventional language.

ARTICLE II.

Voice and Speech.

Voice is a sound which is produced by the vibrations of the air expelled from the lungs, and modulated by the larynx.

The Instrument of the Voice.—The experiments of *Bichat*, and the observations upon openings in the trachea, mentioned by *Magendie* and *J. Cloquet*, in which, speech could not be produced, unless the openings had previously and carefully been obstructed, prove, in the most indisputable manner, that the larynx is the organ of voice.

The Larynx is a small hollow symmetrical apparatus, composed of an assemblage of moveable bones, situated over the median line of the neck, below the os hyoides, on a level with which it opens in the back of the mouth; the larynx is continuous with the cavity of the trachea. It consists of cartilages articulated together and admitting of considerable mobility; of ligaments, of muscles, of membranes, of vessels, of nerves, and glands.

The cavity of this organ is the instrument proper to the voice: it consists of a triangular fissure (*the glottis,*) whose dimensions are variable, the sides are

formed by four membranous folds, known under the name of vocal cords; two of these folds are situated superiorly, and form the opening of the larynx; they are separated from the inferior by two small excavations, termed the *sinuses* of the larynx; a mucous membrane lines the whole of these parts.

Voice.—The air, expelled in expiration, from the chest, reaches the larynx, where it meets with the vocal cords, which are then more or less extended by the intrinsic muscles of that organ; in passing, it receives vibrations, from which sound results, and escapes through the mouth and fossæ nasales. *Galen*, *Fabricius Ab. Aquapendente*, and *Dodart*, pretended, that the air was the sonorous body; *Ferrein*, on the contrary, considered that sound proceeded from the vibrations of the vocal cords, and consequently viewed the larynx as a corded instrument. *Richerand* thinks that these two causes may unite to produce this phenomenon. Most physicians consider the larynx both as a wind and a case instrument, *Magendie* also concurs in this doctrine. The glottis, according to this opinion, forms the body of the instrument.

Intensity of Sound.—The intensity of sound is well known to be, to a certain degree, voluntary; but the quantity of air expired, the diameter of the larynx, and the disposition of the parts through which the air escapes, are so many modifying causes of the intensity of sounds. Thus, in the female, for instance, in

in whom the capacity of the chest, and the diameter of the larynx, are less extensive than in man, and hence the voice is more shrill, &c.

Tune.—The human voice admits of a multiplicity of inflexions, which constitute the different tunes. *Galen* attributed the vibrations of the voice to the variable extent of the trachea, and to the degree of contraction of the glottis. *Dodart* admits of the latter cause only. *Ferrein* refers them to the length and degrees of tension of the vocal cords, from whence there evidently results a different number of vibrations within a given time. *Biot* and *Magendie* have ascertained the reality of these vibrations: they impart a kind of tremor to the larynx, distinctly felt in deep sounds; the vibrations of the voice are also evidently influenced by the degrees of opening the mouth. The extent of the human voice includes nearly three octaves.

Tune (*Timbre.*)—This is of infinite variety. It is thus females have a sweeter voice, something more pleasing in it than men, whose voice is harsh: the cause of these phenomena is still concealed from us.

Ventriloquism is a peculiar and very remarkable illusion of the voice, which, according to *Dumas* and *Richerand,* proceeds from the sound being first confined within the larynx, and returning to reecho in the chest, from whence it escapes but slowly.

The voice evidently has sympathetic connexions with the genital parts; it is, in fact, remarkable that

castrated subjects have a female voice, and amorous females a manly one.

Speech.—Speech is nothing more than the voice articulated by the different parts which form the mouth; and, in particular, by the various motions of the cheeks, of the lips, and of the tongue. Here we are struck with amazement, when we come to reflect what powers it has required in human understanding, to succeed in referring all our ideas to a series of articulated sounds,—*words*, a reunion of which forms *language*, properly called, or *conventional language*. But language so far would be valuable for the present moment only; means of communicating with posterity were required; and here again it is to his own genius that man is indebted for a grand step towards perfection. To this effect, the words have been reduced to a certain number of elementary sounds, which have been represented by signs or letters, the combination of which constitutes writing. Letters are divided into *vowels* and *consonants*: the pronunciation of the former is mild and natural, that of the latter, harsh and difficult; whence unavoidably follows the harshness of languages abounding in consonants; and, on the contrary, the delicacy and harmony of those which most abound vowels.

Man sometimes expresses his passions by *singing*, a modulated voice attended or unattended with words. *Declamation* is a variety of this mode. Every body is aware how powerfully expressive it is.

The pronunciation of sounds is sometimes attended with imperfections, proceeding from mal-conformation in the roof of the mouth or velum palati, from decayed teeth, and frequently from education, &c. These imperfections consist in *stammering, lisping, stuttering,* orin what is vulgarly called, to speak with a *forked tongue,* &c. Dumbness consists in a total privation of speech: it may either be congenital or accidental.

CHAP. V.

OF SLEEP.

Sleep may be defined as the repose of the organs of the senses, and of voluntary motions, or the periodical suspension of such functions as establish our connections with the external world, during which man makes up for his losses, and recovers the faculty of acting.

When waking has been protracted for the space of fifteen or eighteen hours, a lapse of time, varying according as the body has undergone more or less muscular or intellectual fatigue, according to habit or age, or to the presence or absence of either external or internal exciting causes, we experience a peculiar want, impossible to describe, but known to every body by self-experience, (*the want of sleep.*) The motions become languid, the sensations obscure, the superior limbs stretch out, the eye-lids close, respiration slackens, the sensations

vanish, the intellectual faculties die away, the body assumes a semi-flexed position, and such that all the parts may mechanically rest upon the ground.

In this state, man has completely lost the consciousness of his own existence—he is *asleep*. Hence, he no longer exists, but for himself only; his vegetative functions are continued—they are even supposed to increase in energy; digestion is active, respiration deeper, the pulse beats slower but fuller, absorption, nutrition, and secretions, are more active (*motus in somno intro vergunt somnus labor visceribus. Hipp.*) It was probably owing to this reason that the ancients took their principal meal towards evening. Animals sleeping immediately after having fed, &c. is perhaps owing to a similar cause. Heat, however, is evidently reduced during sleep. (*Cum somnus invaserit corpus frigescit. Hipp.*)

Such is the state of organization during rest. After seven or eight hours have elapsed, there results from this state a favourable change, which manifests itself in every function at the moment of *waking*. This epoch is proclaimed by the successive return of internal and external sensations, as well as by muscular action. By stretchings, gapings, and sighs, which return the nervous influx to all the parts and completely dissipate torpor; wants are felt, particularly those connected with secretions, in fact, man rises with renovated energy.

The duration of sleep varies in an unlimited manner—1st. According to ages.* It is on this account that infants require more sleep than adults, and the latter feel the want of it more than the aged subject; 2dly. According to habit; 3dly. According as physical or intellectual exertions have been more active during the preceding state; a sound sleep is an invariable consequence of protracted application; consequently sleep is proportionate with the losses that have been sustained; as the nervous system is more or less disturbed.

The soundness of sleep varies as much as its duration; it may in this respect be divided into *perfect*, that just described, and *incomplete*, during which, are produced some intellectual or animal acts, such as the irregular *motions*, which agitate the body; and dreams, that are nothing more than an action of the brain, generally incoherent, and created independently of the will. Hence proceeds an association of fantastical ideas, frequently relating to the labour or passions of some preceding day. With some individuals, dreams are attended with expressive phenomena. Fi-

* *Buffon* and *Richerand*, and other physiologists, are of opinion, that the fœtus sleeps during the time he remains in the womb; that is to say, during his intra-uterine life. But, notwithstanding the weighty opinion of these eminent men, I consider that the subject should have previously undergone losses that required a renovation. Sleep in short, must be preceded by the contrary state, which, with respect to the fœtus, is not proved

nally, under particular circumstances the functions of relation seem to have completely retained their natural type, and to be wholly directed by the intellects; this is what constitutes *somnambulism*, which has given room for observations as curious as they were surprising.

The true nature of sleep has given birth to several hypotheses. *Aristotle* attributed it to a cooling of the heart, on this organ being forsaken by a kind of humidity, which ascended to the brain. *Homer* and *Plato* viewed it as a state of rest of the soul, rendered necessary by the fatigue undergone in the preceding state. *Willis* would have it to be a result of the compression of the brain. The modern physiologists, who admit of this opinion, question whether the compression is *active* or *passive*. *Broussais* is decidedly of the former opinion. *Avicenni* thought that sleep was attended with a suspension of animal spirits. Most modern physiologists attribute this state to an expenditure of the principle of sensation and of motion. Finally, some authors, in common with *Barther*, have considered sleep as an active function (*somnus est functio activa principii vitalis.*) But we have said before, that every function must unavoidably be provided with an instrument,—where are we to look for that of sleep?

SECOND CLASS.

FUNCTIONS FOR THE PRESERVATION OF THE SPECIES.

CHAP. I.

OF GENERATION.

The different functions we have just been studying, disclose a most admirable provision in nature to insure individual existence; but that would not suffice to perpetuate the human speeies. Man, being eondemned to die, of eourse nature had to provide for his reproduetion; thus, after having had the preservation of the individual in view, all her solicitude has been bent upon that still more important preservation of the speeics—*generation.* It is that precious faeulty, without which the universe would no longer exist, which has

been intrusted to organs belonging to different sexes, between which they form the principal distinctions. Generation includes several distinct acts—*copulation, parturition,* and *lactation.*

ARTICLE I.

A. *Genital Apparatus in Man.*

Is composed of the organs of *fecundation*, and of those of *copulation*: we shall take a cursory view of them.

The Testes.—The testes are two ovoid glands, situated below the pubes, and contained within a prolongation of the skin, termed the *scrotum.* Their parenchyma, similar to that of every other gland, consists of vessels which convey to these organs the materials for secretion, and of excretory ducts. The latter, remarkably minute, and very tortuous, have received the name of *tubuli seminiferi*: their number has been estimated at sixty-two thousand five hundred, their diameter at about two hundredth-part of an inch: they present numerous small expansions, that have been considered as of a glandular nature; they are all directed towards the superior edge of the gland, where they unite into a whitish canal (*corpus Hyghmori.*) The duct resulting from their reunion is reflected several times upon itself, and by its

circumvolutions, forms a small oblong body, which is superadded, as it were, to the organ, and on this account is called the *epididymis.* From the inferior part of the epididymis originates the cord by which the whole organ is suspended within its envelopes; this cord results from the assemblage of the spermatic nerves and vessels, with the excretory duct.

The parenchyma of the testis is contained within a fibrous, dense, thick membrane (*the peritestis,*) which sends off prolongations into the substance of the organ. The testicle is moreover inclosed within a membranous sac, formed—1st. By the *tunica vaginalis*; 2dly, By the *tunica erythroida*, or cremaster muscle, proceeding from the oblique muscle of the abdomen; 3dly. By the *Dartos*, a cellulo-fibrous layer, forming the partition that separates the two testicles; 4thly, and finally. By the skin, which forms the *scrotum,* properly so called.

Vas Deferens.—Is the name given to the excretory duct of the testis, being a continuation of that which is formed by the convolutions of the epididymis. On leaving the testicle this duct ascends with the vessels towards the inguinal canal, which it crosses: in reaching the abdomen, it plunges into the pelvis, down to the inferior and posterior part of the bladder. On a level with the base of the prostate gland, it receives the excretory tube of the vesiculæ seminales; finally, it is continued under the name of ejaculatory duct, to

the prostatic portion of the urethra. The diameter of the vas deferens is remarkably contracted, and its parietes are very thick.

Vesiculæ Seminales are two small bodies, situated posteriorly to the prostate gland, under the bladder, and on the outer side of the vas deferens; their cavity is exceedingly tortuous; their parietes are formed externally by a contractile fibrous sheet, internally by a mucous membrane. From their anterior extremity, a short canal is sent off, which unites with the vas deferens. These small vesicles perform the office of a reservoir for the semen; however, the fluid which they usually contain differs from the former in appearance.

The Penis.—The penis is the last part of the genital apparatus of man. It is the organ of copulation: Situated immediately below the symphysis of the pubis, it is of a cylindrical form, and from four to five inches in length. This organ consists of—1st. The *corpora cavernosa,* which give it form and dimensions; these bodies begin within the branches of the ischium and of the pubes, draw nearer together, and are finally united to each other to form the body of the penis, they extend to the glans, in which they terminate by two conical extremities. The corpus cavernosum consists of an external fibrous membrane, which forms a median partition between the two, sending off prolongations into the substance which fills it. This internal substance, in the expansion of which erection consists, is

composed, according to some, of a spongious tissue, to which veins and arteries are continued. It results, according to others, from a capillary interlacing of arteries, veins, and nerves, supported by a cellular network. 2dly. *The spongious portion of the urethra,* lodged within a furrow of the cavernous body, and which constitutes the inferior part of the penis; its spongious tissue expands at the extremity of the corpus cavernosum to form the glans, a kind of conical organ which contains the seat of the voluptuous sensation attending coition. 3dly, and finally. By the *skin,* which envelops all these parts and extends over the glans, where it forms the *prepuce,* and serves to keep up the exquisite sensibility of the parts.

Such are the parts of the fecundating and copulating apparatus in man. They actually present every character of an apparatus of secretion.

Secretion of Semen.—The testis, by means of the blood it receives from the spermatic artery, produces the prolific liquor; this last fluid travels through the whole extent of the seminiferous ducts, and the epipidymis, it ascends through the vas deferens, to the vesiculæ seminales, where it remains deposited, to be evacuated at the moment of copulation. But, in virtue of what law does the semen run so long and so tortuous a course? To account for this phenomenon, physiologists generally admit of a continuity of secretion, and of a tonic power, and capillarity in the semi-

niferous canals. In the ordinary state, the progress of semen is slow in these ducts, and it is highly probable that this fluid undergoes some modifications in its course; and what seems to prove it is, that during copulation, when its course is much quickened, it becomes more serous—is not so thick in the last ejaculation as in the first. But, then, how does it happen, that instead of habitually following the ejaculatory canal, it takes a retrograde motion towards the vesiculæ seminales? In the second place, what kind of modifications is this liquid liable to undergo in these reservoirs? These are questions, which are very far indeed from having been answered in a satisfactory manner, and which require further investigation.

The Semen is a white, opaque fluid, of an odour sui generis, of a saltish and rather astringent taste. It separates spontaneously into two parts: the one thick, filamentous; the other very fluid and transparent. Some physiologists contend, that it contains a gaseous part, which they have denominated *aura seminalis*. Semen can never be obtained in a perfectly pure state, it is always mixt with a given proportion of humour produced by *Cowper's* glands, by the prostrate gland, and by the mucous membrane of the urethra.

Examined with the glass, semen appeared to *Leuwenhoeck*, to consist of animalculæ. *Buffon*, *Nudham*, and *Spallanzani*, pretend, that these animalculæ are nothing more than those observable in all liquids.

Virey thinks that they consist of small vesicles, wherein is contained a real prolific liquor. Finally, *Dumas* and *Prevost* consider them as the exclusive agents of fecundation.

Submitted to chemical analysis, the semen is found to contain, in a thousand parts, nine hundred of water, sixty of animal mucilage, thirty of phosphate of lime, and ten of soda. *Berzelius* has moreover detected in it the salts of the blood, and a kind of animal matter.

ARTICLE II.

B. *Genital Apparatus in the Female.*

The female parts of generation consist of the organs of germification, of gestation, and of copulation.

Ovaries.—The ovaries are two irregular bodies, of an oval form, situated within the cavity of the pelvis, on the sides of the uterus, in a fold formed by the peritoneum; their organization consists of a fibrous membrane externally, and internally of a spongy greyish tissue, in which are found from fifteen to twenty small transparent vesicles, filled with a viscous fluid, and in general more voluminous as they are more externally situated.

Fallopian Tubes.—The fallopian tubes are two vermiform canals, forming a communication between the ovary and the uterus; on the one part, they open in

the latter organ by a contracted orifice; on the other, they terminate by an expansion called the *pavillon*, which opens into the cavity of the peritoneum: it has a fringed extremity, a part of which adheres to the ovary.

Uterus.—The uterus is the organ of gestation, pyriform in shape, and is situated between the rectum and the bladder; this organ presents for consideration—1st. The *body*, superiorly situated; 2dly. The *neck*, which is inferior, is received in the vagina, into which it protrudes about the third of an inch in length; it opens by a transverse fissure, provided with lips, and called the *os tincæ*; 3dly. The *cavity*, that of the body, presents a curvilinear triangle: it is in the two superior angles that the fallopian tubes open, the inferior angle terminates in the cavity of the neck; the latter slightly concave in its centre, presents nothing worthy of remark.

The tissue of the uterus is dense, compact, elastic, greyish, inextricable in the ordinary state; however, from its aspect during pregnancy, this organ is generally considered as muscular. *Weitbrecht* has detected two small orbicular muscles at the orifices of the tubes. *Sue* says, he has observed four muscular knots, which he considers as central points of contraction. Madame *Boivin* has observed—1st. A muscular membrane, from the body down to the extremity of the neck in the vagina; 2dly. Transverse fibres, situated on each side

of the median line, between the two superior angles, on a level with which they send off continuations, by which the fallopian tubes, the suspending ligaments of the uterus, and the cords of the ovaries, are formed; 3dly. There is invariably under the first layer, but on a level with the body, a sheet, which under the form of an expanding fasciculus, ascends from the orifice towards the transverse fibres, with which it becomes interlaced; 4thly. Interiorly, along the median line, forward and backward, are vertical fibres, curved superiorly to form the orbicular knots of *Weitbrecht*; 5thly, and finally, On each side of the interior *raphe*, and posterior to the neck, this midwife has also found, folds regularly ramified, some of which ascend towards the body of the organ. Such also is nearly the description given by *Bell*. *Ribes* and *Chaussier* are of opinion, that the superficial fibres of the neck are circular, the deeply situated longitudinal, and that they are continuous with those of the body. Exteriorly, the uterus is lined by the peritoneum; inwardly by a mucous membrane: the existence of which has been denied by *Ribes, Chaussier*, and Madame *Boivin*.

Vagina.—The vagina is a vascular-membranous canal, from six to seven inches in length, intended for the reception of the penis, and extending from the neck of the uterus to the *pudendum*, where it terminates. The interior of this organ presents transverse

wrinkles, its external orifice is partly obstructed in the virgin, by a membrane called the hymen, traces of which only are observable in women. A mucous membrane, a layer of erectile tissue, a cellular membrane, and a constrictor muscle, constitute the parietes of the vagina.

Finally, the *pudendum* offers for consideration—1st. The two *external lips,* provided with erectile tissue and a sphincter; 2dly. The *nymphæ,* erectile and endowed with a remarkable degree of sensibility; 3dly, finally, The *clitoris,* an organ consisting of a *corpus cavernosum,* a glans, a prepuce, and which, similar to the penis in man, is susceptible of erection: this organ is the seat of sensual delight.

ARTICLE III.

Organic and Functional Differences between the Sexes.

So far, we have almost exclusively restricted ourselves to the study of man, now I consider it advisable previous to examining the functions that require the concurrence of the two sexes, to devote a few moments to the particular study of the female.

1st. *Stature*—In the early stages of infancy, the most skilful eye can hardly detect the slightest difference in the exterior habit of the two sexes, but this is

no longer the case at the epoch of puberty. In man, the muscular projections denote strength; the beard covers the chin; whilst in the female, the form becomes rounded and graceful, the breast swells, the features retain the mildness of adolescence and youth, the head remains smaller; and, generally speaking, the neck is longer, the chest narrower, the shoulders more dropping, the arms thicker, the hand smaller, and the delicacy of the fingers gives to these small organs a remarkable degree of elegance. The pelvis also becomes more expanded, the limbs shorter, the knees thicker and inwardly inclined, the feet smaller; finally, the osseous projections are better concealed, the cellular and adipose tissues being less sparingly diffused. The form is slighter, more delicate, and elegant; the skin is fine and fairer, whilst the hair of the head, growing to some considerable length, becomes the source of an additional charm.

2dly. *Nutrition.*—The organs, concurring in this important function, are always less developed in the female than in man. Thus she requires a lesser quantity of food than we do. Hunger is more capricious, if I may be allowed the expression, but sooner satisfied. Respiration is shorter but quicker, circulation more rapid, the pulse weaker, and secretions, generally speaking, with the exception of that of fat, less abundant.

3dly. *Sensations.*—The brain is somewhat less de-

veloped in the female subject than in the male, but in the former the nerves are thicker and softer; females evidently surpass us by the delicacy of their sensations, and the acuteness of their senses. Only consider the vivacity of their looks:—their other senses are not less penetrating. Hence a multiplicity of sensations and of impressions which escape man, and which impart to the fair a character of benevolence, of tenderness, of compassion, and devotion; hence also, a number of ideas, which succeed each other too rapidly to admit of being matured by reflexion, and, as a natural consequence, arises that versatility so justly complained of. In vain do the fair sex pretend to constancy: their very organization implies contradiction. The facility with which they receive impressions, must forcibly compel them often to change their minds, and become the source of a number of capricious ideas and whimsical thoughts, for which they cannot account—no, not even to themselves. From this continual and rapid versatility in the nervous system of females, they are unqualified for deep studies, their imagination cannot rise up to the sciences. They are possessed of nothing like the profound and sublime, in the mind; but their wit is graceful, their conversation interesting and lively, teems with humour; for this reason they excel in music, and in the art of depicting faithfully the emotions of the human heart.

Locomotion.—In the female, the organs for motion

differ from ours: the bones are thinner and shorter, their curves slighter, their muscles thinner also, for which reason they do not admit of much effort. The cotyloidian cavities are more distant, whence results a considerable rotatory motion in the pelvis during progression, and which we have termed graceful.

3dly. *Expressions.*—The female being possessed of sensibility in a very superior degree, her language of expression must be considerably varied and remarkably intelligent. Her *voice* also must differ from that of man, by reason, that the apparatus is smaller, her voice is generally sweeter, more harmonious, and more touching.

6th. *Sleep.*—Lightness appears to be the essential character of every act of female life: sleep, in this subject, is not so sound as in man, nor is it of the same duration.

7thly, finally. *Menstruation.*— Nothing similar to this is observable in man: it consists of a vascular exhalation, periodically occurring, once a month, and continued for four or five days, proclaiming as it were fecundity.

The epoch at which the menstrual discharge begins, is from the age of thirteen to fifteen in our climates, long before that time in the south, and much later towards the north.

The menses sometimes appear suddenly, without any precursory symptom; but, generally, they are

preceded by an uncomfortable, vague sensation, of heaviness in the lumbar region, a pricking in the breasts, a troublesome itching in the genital parts; their appearance even in some cases is attended with serious consequences, intense fever; the skin becomes red and hot. The young and unconscious virgin attributes the disease to the lumbar region, or the epigastric; but, at length, a few drops of blood appear, and with them flows away the whole series of mischief and complaints.

The discharge seldom has a character of regularity on its first appearance, generally a few months elapse before it assumes a menstrual type. During the course of life, also, it is liable to vary, either with respect to the time of its return or of its duration, and even to the quantity of blood discharged; or, again, as far as is related with the nature of the phenomena, that precede, attend, or follow the lochia.

At last a period arrives when this periodical discharge has ceased, and with it a possibility of generation. This generally occurs between the age of forty-five and fifty in our latitudes, later towards the north, and sooner in the tropical regions; this epoch is frequently marked by the most serious accidents: hence the name of *critical time*, which has been given to it.

Some physiologists have pretended to explain the periodicity of menstruation, by a kind of uterine fermentation, by a super-abundance of food, productive

of an inordinate quantity of blood, by a determination of the soul! It is generally admitted, that the female, at the age of puberty, is provided with a sufficient quantity of blood, to supply two individuals, and that it is by menstruation, when out of the state of pregnancy or of lactation, that she rids herself of the superabundant fluid.

ARTICLE IV.

C. *Of Copulation.*

Copulation consists in the immediate union of the genital organs of the two sexes. It is the act productive of that sensual delight, which entices us to reproduction.

Sensation Enticing to Coition.—Careful Nature has attached attractive pleasure to the accomplishment of the functions by which individual existence is insured, and, she has had no less forethought for those which have the protection of the species in view. At the epoch of puberty, a lively sensation, irresistible, hitherto unknown, breaks forth, leads to a union of the sexes, and inclines them to copulation. This sensation, perfectly distinct from all others, has been attributed to the genital organs, by most physiologists; *Gall*, on the contrary, has made it one of the faculties of the soul; according to this author, it is a cerebral phenomenon, the seat of which is in the cerebellum.

Man, led by this sensation, soon enters into a state of *erection;* that is to say, the penis swells, becomes stiff, by a considerable affiux of blood into the corpus cavernosum, the urethra, and the glans; from this moment, the organ, which has acquired considerable strength by its active congestion, surmounts every resistance offered by the vagina, and penetrates deeply into that organ, directing itself towards the neck of the uterus: The burning heat communicated by the female parts, the voluptuous friction it experiences, propagates its orgasm to the whole economy, and particularly to the organs of fecundation; the testicles, drawn nearer to the ring, and tightened in their envelopes, increase their activity; the vesicles contract, and propel the semen which they contained, into the canal of the urethra, which it reaches conjointly with that proceeding directly from the testis; from that moment, by means of the convulsive action of the elevator-ani ischio and bulbo-cavernous muscles, and of the canal itself, the semen is propelled with a delightful sensation,—words cannot describe,—which throws the subject into a kind of convulsion, sometimes even forcing cries from him; the sensation is more or less protracted; but the penis is instantaneously restored to its primitive state.

During coition, the female performs no passive part: the sensation of desire determines an active

congestion in all the erectile parts of the vulva and vagina, the approach of man, and particularly the introduction of the penis, throws her into a voluptuous orgasm, which gradually increases, so far even as to produce cramps, and general convulsions, which terminate by a secretion of a more or less considerable quantity of mucus from the vagina, and which is succeeded by a state of total prostration which itself is far from being void of pleasure.

ARTICLE V.

D. *Of Fecundation.*

By fecundation is understood the mechanism of the creation of a new being, by the contact of elements supplied by two individuals of different sexes.

In the first place, with respect to man, it is beyond doubt, that the semen is the only fecundating fluid, as has been proved in the most indisputable manner by the artificial fecundations of *Spallanzani*, tried upon frogs and dogs, and by those of *Jacob* upon fishes. These ingenious experiments have been repeated with very desirable success by *Dumas* and *Prevost*, who have remarked, as *Spallanzani* had previously done, that the semen, to become fit for fecundation, required to be diluted.

Some physiologists are of opinion, that the semen

deposited in the vulva-uterine canal, is there absorbed to be subsequently conveyed by circulation to the ovary; others pretend, that the spermatic fluid evaporates into vapour, which they have termed (*aura seminalis*,) and which immediately proceeds to that organ; but it has been generally admitted, that this liquor, at the moment of ejaculation, is darted into the uterus, or even that it is drawn into it, by a kind of aspiration in its orifice: *Ruysh* has found it in this organ, in a young woman detected by her husband in a criminal connection, and killed by him in the very act of copulation.

On entering the womb, the semen, according to *Dumas*, *Chaussier*, and some other physiologists, fecundates the egg, which, on the other hand, had also entered the uterus; or again (and this last opinion appears to prevail,) at the moment the voluptuous orgasm attending coition takes place, the fallopian tube itself undergoes a kind of erection, during which its fringed part grasps the ovary, and conveys to it the fecundating liquid. *Haller*, in fact, has detected semen in the fallopian tube up to the ovary. *Graaf* and *Magendie*, a few hours after copulation, have found the fringe, strongly applied over the ovary; the abdominal pregnancies, and those of the tubes produced at will by *Nuck*, on applying a ligature to the tube of the uterus, seem to substantiate this opinion.

With respect to the female, it is also evidently

proved, that her share of the supply for the accomplishment of fecundation proceeds from the ovary. *Harvey* was the first who contended that an egg dropped from this organ, *Graafe* demonstrated this fact by precise experiments: He considered the egg as consisting of two membranes and a transparent fluid. *Haller*, and long after him, *Dumas* and *Prevost*, have attempted this subject by new experiments: they have witnessed, subsequently to a fecundating coition, a vesicle unfold itself in the ovary, increase in size for four or five successive days, then burst, and an *ovule* escapes through the small opening, and leaves a yellowish spot after it. Viewed with the glass, this small human egg presented a cicatricula, not unlike that observable in vegetable seeds.

At the moment this ovule detaches itself, the fringed part of the tube seizes it, and conveys it into the cavity of the uterus. *Brissiere* has witnessed this diminutive body, partly in the interior of the tube, whilst it still slightly adhered to the ovary.

All that has just been stated is grounded upon observation. We have been able to follow nature throughout every part of her operations. But if we attempt to penetrate into the very essence of vivification, observation fails us at the very first step, and we are again reduced to the uncertainty of hypothesis. All the theories that have been brought forward respecting generation may be reduced to the two following.

1st. *Epigenema.*—The authors of this hypothesis pretend, that the new individual is formed by a mixture of the materials produced by the two sexes, in virtue of a power, called the force of *formation.* *Lamark* thinks, that organized bodies arise from a spontaneous generation, taking place under the influence of a vivifying cause, which cause probably proceeds from light and electricity; this author adds, that every time this cause comes in contact with a gelatinous substance, it produces living beings, that it is thus the human embryo is formed, which, from this first degree of organization, gradually rises to that proper to man. *Hippocrates* admitted, in the sexes, of a male semen, and of a female substance, which, by the means of heat, produced new beings by a sort of animal chrystallization. *Descartes* speaks of a kind of ferment in the two semens. *Pascal* pretends, that their combination is a natural and unavoidable consequence of their chemical nature, the one being acid, the other alkaline. *Buffon* admits of living particles, and is of opinion, that generation is effected by the combination of these *molecules,* which he calls *organic,* with a small proportion of dead matter, &c.

2dly. *Evolution.*—In this system the germ is supposed to be supplied either by the male or female, and in consequence of a series of gradual developments, ultimately to constitute a new being. The believers of this doctrine are divided into two sects.

1st. Some, from analogy with oviparous animals, argue, that the body which proceeds from the ovary is an egg, consisting of an embryo, and of particular organs, intended for its nutrition and development; that this embryo contains the germ of a new individual, which requires for its development nothing more than the favourable circumstances dependant upon fecundation. Amongst the ovarists, there are some, at the head of whom we find *Bonnet*, who pretend that all the eggs are contained within each other, so as to be successively fecundated, that the first female contained the whole human race in one single egg, and that consequently, at some future period, there will be an end to this race by the exhaustion of the reproducting ovules. Others pretend that every female produces her eggs by means of a kind of secretion.

2dly. Subsequently to the discovery of the spermatic animalculæ, most physiologists considered them as the rudiments of new individuals. *Audre* asserted, that they penetrated into the vesicles of the ovary, to borrow from them the first elements of nutrition, and that subsequently they were restored along with the ovule to the cavity of the uterus. Animalculism, as they termed it, had been generally laid aside and forgotten, when *Dumas* and *Chaussier*, by ingenious researches, have again presented the spermatic animalculæ as the agents of fecundation. These experimentors pretend that the ovule is nothing more than a cellular bed, in

which the organs are formed; and, in consequence of the first fœtal lineaments they have detected, these authors conjecture that the animalcula contains the rudiments of the nervous system of the new being. *Rolando,* who had adopted this hypothesis, professes that the ovule supplies the embryo with the rudiments of the cellulo-vascular system, and that the spermatic animalcula contains those of the nervous.

However, most modern physiologists, whilst they admire the efforts of these skilful experimentors to penetrate into the secrets of conception, openly acknowledge, that the science, as far as relates to this phenomenon is involved in too much obscurity to allow of a satisfactory explanation.

Let this be as it may, fecundation is irresistibly effected; the will has no influence over it. It is not within our power, voluntarily to create the sexes; we can by no means whatever influence this function, neither with respect to the number of children, nor with regard to their future physical or moral qualities.

ARTICLE VI.

Development of the Ovula in the Uterus.

Let the divers hypothesis on fecundation be what they may, it is true, that the fecundated ovule contains the elements of a new being; the cicatricula

presents an exterior zone, which is *opaque*, and an internal one, *transparent*. In the centre of the latter, we discover the rudiments of the nervous system. Such is the state of the fecundated human ovule, on reaching the cavity of the uterus.

The early changes in the development of fœtal organization are involved in impenetrable obscurity. We have not even up to this very day succeeded in clearly ascertaining the precise moment at which the new being becomes discernible in the human ovum.

Three weeks after fecundation, the embryo appears under the shape of a small worm, expanded towards the middle of the body, and free within the ovum, or rather adhering to the internal membrane, by that part which at a future period will answer to the point of insertion of the umbilical cord. This diminutive, worm-like body, contained within a membrane (*the amnion*,) exclusively belongs to the trunk; already a small circle, which forms the rudiments of the vascular system is observable; soon, a small pulsating cavity develops itself over this circle (it is the *heart*;) soon after this again, we remark, at the superior part of the trunk, a small projecting expansion, separated by a slight fissure; this is the origin of the head, which rapidly acquires a considerable size; at this early stage of life, the spinal marrow becomes more developed and distinct, the nerves also begin to point out their courses.

Towards the sixth week, two small black spots proclaim the unfolding of the eyes, and a transverse fissure, that of the mouth, appears shortly after, the lineaments of the superior limbs, are discernible, and subsequently the inferior. The intestinal tube now assumes a perpendicular situation in front of the spine, the anterior wall of the abdomen forms a conical projection, which still immediately adheres to the membranes of the ovula. The whole ovule presents an ovoid form, about one inch and a half in length, and an inch or an inch and a quarter in breadth.

A short time after this, the embryo separates from the membranes of the ovule, the parietes of the abdomen assume a funnel-like extension, to form the umbilical cord ; at this stage, in front of the inferior extremity of the spine, which is curved in the shape of a tail, appear several openings: these are the rudiments of the anus and of the genital parts.

Between the ninth and tenth week, the mouth closes, by the lips drawing together: but this cavity still presents a free communication with the fossæ nasales; the eyelids close the eyes, the auricular openings begin to appear, the kind of spinal tail shortens, and the fingers assume their respective position.

Toward the third month, all the parts of the face become perfectly distinct, the anterior part of the chest is closed by the sternum, the intestine previously contained within the umbilical cord, enters the abdomen,

the skin begins to acquire some degree of organization, and the embryo is from five to six inches in length.

Between the fourth and fifth month, the parts become proportioned, and gradually more distinct; ossification evidently makes some progress, the skin assumes a certain degree of consistence, and a reddish fat substance fills up the cells of the cellular tissue.

Finally, as we gradually draw nearer to birth, the skin covers itself with a delicate peach-like down, the follicles which are much developed secrete an unctuous whitish humour, the hair grows, the parts become firm, rounded, and acquire the proportions which characterise the human species.

The embryo is not free in the cavity of the uterus, it is contained within particular membranes, calculated to secure it, and intended for nutrition and growth by establishing functional connections between it and the parent. It becomes then indispensible to examine these accessory membranes previously to tracing the history of fœtal life.

ARTICLE VII.

Of the Fœtal Membranes

At the moment of coition, the uterus partakes of the orgasm of the other sexual parts; and when fecunda-

tion is the consequence, the turgescence is kept up, the walls of the uterus evidently acquire thickness, become softer and more vascular; at the same time, the cavity dilates, and fills with a sero-albuminous matter, which becomes organized in the shape of a membranous sac, and which the fecundated ovule pushes forward on entering the womb through the orifice of the fallopian tubes: this membrane, termed *decidua* by *Hunter*, *epichorion* by *Chaussier*, falls back upon itself by reflecting over the whole surface of the ovule, which however it no more contains within its cavity, than the pleura does the lungs, as has been demonstrated by *Moreau*, *Velpeau*, and *Breschet*. Thick at first, soft, *pulpy*, not unlike the cuplike part of the blood, the decidua becomes thinner, as we approach nearer to birth, being at the same robbed of its organization and becoming an inorganic substance.

This membrane, as we have just seen, does not belong, properly speaking, to the ovule, it is merely intended to secure it within the uterus during the early stages of gestation; whilst those we are about to study, especially belong to the embryo.

2dly. *Chorion.*—This membrane is the most external of the human ovule: thin and transparent, its external surface is provided with numerous vascular villosities, which connect it with the preceding membrane, except where the latter becomes reflected within itself by the ovule, and where these villosities will at some

future period form the placenta; the internal surface equally covered with the villosities corresponds to the membrane of the amnion, from which, in the early stage of conception, it is separated by a certain quantity of serosity. *Velpeau* has clearly demonstrated that this membrane consists of one single sheet only, instead of two, as was generally supposed before; according to this author, the chorion is perfectly distinct, as early as twelve days after conception.

3dly. *Amnion.*—The amnion is the first membrane that unfolds itself: it is thin, white, and transparent; and, during the two first months of pregnancy, is separated from the chorion by a fluid called the *false waters of the amnion;* afterwards, it coheres to this membrane through the means of cellular filaments, which have been mistaken for vascular; it lines the fœtal surface of the placenta, ascends along the umbilic cord with which it becomes intimately connected, from whence it is continued with the epidermis of the embryo, as we find it demonstrated by *Velpeau.* It has not yet been ascertained whether this membrane receives its vessels from the parent or from the fœtus. *Chaussier* has injected them through the mother; *Monro* through the child, which makes it highly probable that it receives some from both.

This cavity contains a fluid known under the name of *waters of the amnion,* which are now more abundant, as we approach nearer to the complete formation

of the ovum. This humour, at first clear and transparent, becomes viscous and loaded more or less with caseous flakes; its source has not been properly ascertained. Some will have it to proceed from the mother, others from the fœtus, and under the latter point of view, some physiologists consider it as the result of cutaneous and urinary secretion.

The analysis of these waters has been made by *Vanquelin;* and this eminent chemist has found them to contain water, albumen, soda, hydro-chlorate of soda, lime, and phosphate of lime: *Berzelius* detected in them fluoric acid; *Scheele,* oxygen; *Lassaigne,* atmospheric air.

Placenta.—The placenta is either a rounded or oblong mass, vascular, spongious, thicker in its centre than at the circumference, from six to eight inches in diameter, formed at a point of the outer surface of the chorion; the placenta, on the one part, adheres to the uterus; and by the other end to the fœtus, by means of the *umbilical cord.* This body results, according to *Velpeau,* from the development of gangliform granulations, observable on that part of the external surface of the chorion, which does not correspond to the decidua, and which consequently is in immediate contact with the womb. Thus it is generally situated in that part of the organ near to the orifice of the fallopian tubes. *Velpeau* is of opinion, that these granulations contain the rudiments of the vessels of the placenta.

The uterine surface of the placenta is lined by a cellulo-vascular membrane, remarkably thin. Its fœtal side presents, in its centre, the insertion of the umbilical cord: it is lined by the chorion and the amnion. The organization of the placenta consists of—1st. Arteries and veins, which proceed from the uterus, and ramify in the substance of its corresponding surface; 2dly. Of arteries and veins, proceeding from the fœtus, and which ramify on the opposite surface; 3dly. Of white filaments, generally taken for obliterated vessels; 4thly. Of cellular tissue; 5thly. Of lymphatic vessels; 6thly, and finally. According to *Ribes* and *Chaussier*, of nerves, sent off by the grand sympathetic of the child.

5thly. *Umbilical Cord.*—This is a vascular cord, which opens a communication between the placenta and the fœtus: in the early stage of conception, the embryo adheres immediately to the amnion by the anterior part of its abdomen. The cord consists—1st. Of the umbilical vein, which comes from the vena-cava inferior, and ramifies in the placenta, after having communicated with the liver and the vena-portæ: 2dly. Of the two umbilical arteries, which are continuations of the primitive iliac—these also proceed to the placenta; 3dly. Of the urachus; 4thly. Of the omphalo-mesenteric vessels; 5thly. Of nervous threads, sent off by the grand sympathetic; 6thly, and finally. Of a cellulo-gelatinous tissue and of envelopes.

6th. *Vesicula Umbilicalis.*—This vesicle, the existence of which has been denied by some anatomists, but is now generally admitted, consists of a smal granulated sac, filled with a yellowish humour, situated below the anterior part of the embryo, and is compared with the vitellus in birds. In fact, similar to the latter, this vesicle receives the omphalo-mesenteric vessels; it begins the intestinal canal, as has been demonstrated by *Wolf, Hunter, Oken, Bojanus, Meckel,* &c. and it completely disappears towards the third month.

7th. *The Allantois.*—With respect to the actual existence of this organ in the human fœtus, opinions are divided: *Nudham, De Graaf; Haller, Cuvier, Meckel,* &c. admit of it. The allantois is a small reservoir, situated between the chorion and the amnion, or according to *Velpeau,* externally to the chorion, communicating with the bladder by means of a canal, called the *urachus;* the allantois contains a limpid fluid, which has been supposed to be the urine of the fœtus, or by some, a kind of alimentary substance kept in store.

ARTICLE VIII.

Physiology of the Fœtus.

INTRA UTERINE LIFE.

1st. *Nutrition.—Chaussier* is of opinion, that the sero-albuminous matter, which fills the uterus at the time of fecundation, is intended for the nutrition of the embryo, during the earliest stages of its development. But we have said, on *Moreau* and *Velpeau's* authority, that this substance was already converted into a membrane (the decidua,) when the ovule enters the uterus. Subsequently to these authors, the fluid contained within the umbilical vesicle, has been supposed to be the nutritious substance. In support of this argument, the analogy existing between the humour and the yolk of the eggs of birds, has been produced, which, as we are perfectly aware of, has been assimilated to the *cotyledon* of vegetables; this ingenious comparison appears highly probable. In fact, in the same manner that we see these cotyledons drop and fade away as soon as the root of the plant has acquired a certain degree of development, and in the like manner also as the yolk of the egg is absorbed by the increase of the forthcoming subject; in the same manner, we say, the umbilical vesicle, which is considerably developed in the human ovule, is found to dis-

appear gradually, and in proportion as the placenta unfolds itself. According to this hypothesis, the sac is supposed to pour the nutritive substance into the intestinal canal, where it undergoes digestion; but it is far more probable that this fluid is directly conveyed to the vascular system by the intermedium of the omphalo-mesenteric vessels. A considerable number of physiologists have referred fœtal nutrition to the water of the amnion. Some, as *Osiander*, *Buffon*, *Vanderbosch*, will have it to be absorbed by the skin; others, *Boerhaave*, *Haller*, &c. are of opinion, that this substance is conveyed through the mouth to the digestive apparatus; and, finally, a few others, *Ræderer* and *Winslow*, for instance, consider it to be admitted through the respiratory tubes. But all these opinions are nothing more than hazardous speculations. Some physiologists are of opinion, that the blood is conveyed directly from the mother to the fœtus through the means of the villosities, by which the uterus becomes connected with the decidua, and the latter with the chorion. But to substantiate this assertion would first require that the vascularity of these villosities should be demonstrated. *Meker* considers the gelatinous substance contained within the umbilical cord, as the source of nutrition. Finally, the placenta is most generally supposed to be the source of nutrition. The unfolding of this organ, which coincides with the disappearance of the umbilical vesicle,

tends to prove that they actually are, if not the only, at least the principal agents of fœtal nutrition; that it is the vesicle which provides the supply during the three first months, and that the placenta succeeds in the office to the time of birth. The ancients supposed that the blood went directly from the mother to the fœtus, through the placental vessels. But, injections have since proved that there exists no such direct communication. It is now generally admitted, that the vessels of the uterus deposit upon the parietal face of the placenta, a fluid which is subsequently absorbed by the ramuscula of the umbilical cord.

Now that we have made ourselves acquainted with the principal sources from which the fœtus borrows the materials intended for its growth, let us examine through what process these substances are converted into its own substance. Most undoubtedly, the embryo makes its own blood from the humour of the umbilical vesicle, in like manner as birds make theirs from the vitellus. But through what mechanism does this take place? This question can be answered by conjectures only. In the second place, what is the nature of the fluid conveyed from the uterus to the placenta? And, in what state does this fluid reach the fœtus? This part of intra-uterine physiology is involved in the deepest obscurity. *Geoffrey St. Hiliare* pretends, that a considerable portion of the blood supplied by the mother is distributed to the liver by means of the secretion of a particular kind of bile poured

into the intestine, where it stimulates an abundant mucous secretion, and that this mucus is uninterruptedly directed towards, and absorbed by, the chyliferous vessels, and subsequently conveyed to the circulatory system. According to this physiologist, the *meconium* is an evident proof of fœtal digestion.

According to some physiologists, the placenta fulfils the office of a respiratory organ, that is to say, that the blood is conveyed to it to be therein vivified. Such, in particular, is the opinion of *Lobstein*, *Schreger*, *Beclard*, and particularly of *Meckel*, who admits of no other use for the placenta.

The motion of the blood in the fœtus varies at different periods of life: 1st. In the early stage, we find nothing more than the ramifications and the trunk of the omphalo-mesenteric vein, the parietes of which are not at this stage perfectly distinct from the general mass of the embryo, at this time there is no circulation, properly speaking. 2dly. Subsequently to this, the vein opens into the vena-portæ, which leads to the heart at its superior part; from this last organ originates the aorta, extended inferiorly to form the vitellary artery, from this moment simple circulation takes place; the blood proceeds from the umbilical vesicle to the heart, from the heart it is distributed to the body, from whence it is returned by the omphalo-mesenteric artery. 3dly. Subsequently to this, the placenta developes itself in common with the two umbilical

arteries and vein, which unite in the liver with the vena-portæ, and, at this stage of life, circulation becomes more complicated. Finally, the vascular system attains perfection, circulation begins to trace two circles. We have previously noticed the character it assumes at the epoch of birth.

The blood, distributed from all the parts, develops, and in some measure may be said to secrete the organs, it serves to their ultimate increase and perfection; remarkably simple at first, these organs gradually assume a more complicated texture, undergoing, as it were, the different degrees of organization observable in the animal scale. In a word, during uterine life, Man appears gradually to rise from a low degree of organization, until he reaches that peculiar to his species.

Finally, to terminate the history of the fœtus, nothing more remains to be said, than that, in this subject, we observe several secretions, such as the cutaneous, the serous, the synovial, the adipose, bile, and urine. Some physiologists consider the *meconium*, as a secretion.

With respect to functions of relation and reproduction, the former are very doubtful, the latter evidently do not exist.

ARTICLE IX.

E. *Of Gestation.*

By gestation is understood the time from which the product of conception remains in the uterus to the moment of birth.

The ovule, confined within the cavity of the uterus, gradually increases during nine solar months, the period required for gestation; the uterus is proportionally increased in size. During the course of the two or three first months, the effect is not very sensible externally, the body of the organ assumes a round appearance, and sinks lower down in the pelvis; it soon requires more space, and gradually ascends to the hypogastric region, the neck at the same time receding from the orifice of the vagina; finally, towards the latter months, it occupies the whole of the umbilical, and a great part of the epigastric region; at this stage, the neck softens and dilates, and ultimately becomes completely obliterated. The uterus now assumes an ovoid form, the vagina extends, the mucous secretion is more abundant, the ovaries apply closely over the sides of the womb, the abdomen undergoes considerable distension, and the neighbouring parts become compressed, &c. &c.—at the same time, the structure of the uterus changes, this organ evidently becomes

muscular, and the periodical discharge ceases. Some physiologists attribute the dilatation of this organ to the growth of the embryo, others consider it as proceeding from a particular mode of nutrition.

ARTICLE X.

D. *Birth.* (*Accouchement.*)

Birth, properly speaking, is the expulsion of the fœtus, from the womb of the parent. It is a function as natural as that of defecation, as far however as refers to natural labour. Here I do not intend to speak of such cases as may require mechanical assistance. Birth has a determinate epoch.

1st. *Causes.*—It was formerly supposed that labour was brought on by the weight of the fœtus, or by its efforts to disengage itself from the womb. *Buffon* accounted for it by the placenta separating from the uterus. It is now generally considered to proceed from the increased irritability of the organ, and from its mode of dilatation, and subsequently from changes that occur in the circulation of the placenta. In fact, as we gradually draw nearer to parturition, a part of the the vessels become obliterated, and as a natural consequence the blood flows to the uterus, and solicits the contractions of that organ.

2dly. *Conditions required for Delivery.*—In order

that the expulsion of the fœtus may be natural and easy, it requires a perfect conformation in the female, and that the dimensions of the excretory canal should be equal to the volume of the child, that the neck of the uterus should become thin and supple, as well as the genital parts endued with a suitable degree of humidity. On the other hand, the fœtus, well formed, must present one of the extremities in the ovoid form, which it has in the uterus. The most favourable and the most common circumstance is, when the head enters the pelvis in such a direction that the occiput corresponds with the left acetabulum, and the forehead to the right sacro-iliac symphisis; in this position, the occiput has but a very short distance to cross to clear the pubic arch, and the back presents sufficient surface to the action of the abdominal muscles.

3dly. *Mechanism.*—At first, an internal peculiar sensation warns the mother that birth is about to take place, this sensation is attended with pains, which are slight at first, and occurring at long intervals; they become the more and more intense and frequent, as the moment of birth draws nearer.

In labour, accoucheurs distinguish several periods. *A. Petit* and *Desormeaux* admit of three, *Chaussier* of five, we shall reduce them to four.

Preparation for Birth.—The head of the fœtus, contained within the neck of the uterus, descends into

the pelvic eavity, so that the abdomen relaxes, and the mother feels relieved, the symphyses of the pelvis slightly yield, the vagina moistens and dilates, the neck of the uterus opens in consequence of slight contractions in the body of the organ.

Dilatation of the Neck.—The dilatations increase and gradually beeome more painful, they assume an intermittent type, and a longitudinal direction, i. e. from the body to the neck, so that they tend to dilate the latter. They uninterruptedly succeed each other, and during their continuance the fœtal head has a tendency to pass the orifice of the uterus, which, in eonsequence of the distension, considerably adds to the intensity of pain; at the same time, the membranes of the ovum separate from the circumference of the plaeenta down to the opening of the neck, in which they protrude in the shape of *a sac;* at a certain stage of the labour they rupture, and the waters flow, being frequently stained with a little blood. Finally, the head of the child, immediately in contact with the orifice it has to cross, occasions a suitable degree of dilation in the parts.

Expulsion of the Fœtus.—When the orifice of the uterus is sufficiently dilated to give passage to the child, the contractions and pains increase. Finally, the head, after several successive efforts, passes the neck of the womb, and descends into the vagina. In this position the chin is flexed over the chest, the occiput presses downwards against the left aeetabulum, and

the face upwards, in the excavation of the sacrum. From this moment, the contractions of the abdominal muscles unite with those of the uterus, and the head advances forward, undergoing a slight motion of rotation, by which the occiput is carried under the pubic arch, the os coccygis is depressed by the face, the perineum grows thinner; the nymphæ are obliterated, and the labia considerably distended, widely gape. The pelvis remains fixed by the lumbar muscles, and by those of the inferior extremities, the mother strongly grasps all that comes within reach, with her hands; finally, the contractions become almost continuous, the head disengages itself from under the pubes, and by a last and painful exertion it crosses the vulva. The remainder of the body follows without difficulty; and from this moment the child breathes and enjoys a life independently of the mother.

Delivery.—Shortly after the expulsion of the fœtus, fresh pains occur, which occasion the separation of the placenta, and the excretion of the secondary membranes. If some shreds of the decidua are left behind, they are subsequently expelled with the loehia; finally, the woman, completely delivered, enjoys a refreshing and delicious rest, which, in common with the blessing of being a mother, indemnifies her for the inexpressible sufferings attending labour.

ARTICLE XI.

Of Lactation.

The moment a ehild breathes, he enjoys an insulated life. But he is too weak to eollect from around him the materials required for his growth; besides, his digestive apparatus is imperfeet, and his organs are too delicate for common food. Now again, the mother is intrusted with the important eare of providing for the infant's maintenance for a few suecessive months after birth. Sueh is the end laetation has in view.

1st. *Organs.*—At the epoch of puberty, the lateral parts of the chest in the female present two hemisphcrical projeetions, hard and firm in the virgin, softer in women who have born children: these projections are eovered with a softer, finer, and whiter skin, than any other part of the body,—these are the breasts; in their centre, we observe an areola, provided with follicles, which exhale an unetuous fluid to proteet the nipple from the action of the saliva of the child. In the centre rises the *nipple*, a eonoid erectile projeetion, at the surfaee of which the laetiferous tubes open.

The most important part for consideration is the *mammary gland*, a kind of uneven convex body, re-

sulting from an assemblage of glandular lobes, connected together by dense cellular tissue; these lobes are themselves formed by smaller, which may finally be traced to miliary granulations; these receive arterial ramifications, which supply them with the materials of secretions, and give birth to the lactiferous vessels, which vessels, flexuous and semi-transparent, are reduced to trunks, gradually increasing in size, and which direct themselves towards the middle of the gland, without proceeding from one lobe to another; afterwards they form sinuses of different forms and sizes, and they ultimately produce small excretory ducts twining in the centre of the nipple, and opening at its surface.

2dly. *Function.*—During pregnancy, the breasts are seen to swell, and sometimes to secrete a serous fluid. During the two first days after birth, the secretion increases, but it yet produces nothing more than a sweet serous fluid, slightly purgative, called *colostrum*. Finally, from the third to the fourth day, the breasts swell, harden, become hot, painful, and the secretion of milk begins; the suction of the child, as well as his little hands, which generally move over the breast, cause in the organ a voluptuous orgasm, which stimulates the secretion.

The mechanism of this function is similar to that of every other glandular secretion. However, *Richerand,* considering the quantity of lymphatic vessel, which

ramify in the breasts, and which become dilated during lactation, considers that the milk proceeds from the lymph. Other physiologists maintain that it is derived from the chyle: *Gerard* will have it to come from the uterus by means of vessels, but he never could detect them. With respect to the secretion, it generally takes place during suction; but, during the intervals, the milk accumulates in the vessels and in the sinuses, the breasts swell, and soon feel loaded; the small fræna, situated at the orifice of the lactiferous vessels, prevent the spontaneous effusion of milk.

3dly. *The Milk* is a mild, somewhat sweet fluid, of an opaque white colour, and having an odour *sui generis*. *Berzelius* distinguishes in it *cream* and *milk*. According to this author, the cream consists of butter, cheese, and serum; the latter contains sugar of milk and a few salts. The milk yields a great proportion of water, a small quantity of cheese, sugar of milk, muriate, phosphate, and acetate of potash, phosphate of lime, lactic acid, and tartrate of iron.

After ten or twelve months have elapsed, the secretion ends with the act of reproduction.

APPENDIX.

CHAP. I.

OF AGES.

The name of AGE has been given to the modifications which man and all organized beings undergo in their organization and phenomena from the time of birth to that of their natural death. These organic and functional changes gradually occur, and coincide with the succession of years; insensibly occurring from one day to the next, they end by stamping our organs with dates, which form a calender for the physiologist and physician, and which, with respect to man, divide the career of life into distinct periods sufficiently appreciable without further references.

The division of ages varies according to physiolo-

gists: 1st. Some authors, considering the whole of the economy, and particularly the nutritive functions, admit of three: *the age of increase, the stationary*, and that *of decrease*. But first, let us consider whether or not there really be such a thing as a stationary age? In the second place, are we able to ascertain the precise time at which one of these ages ceases, and the other begins? 2dly. Other physiologists, taking only the function of reproduction into consideration, also propose three ages, according as the power of reproduction may not yet exist, as it can be accomplished, or as it has ceased. 3dly. Finally, *Halle* divides the the ages into five, namely: *infancy, second infancy, adolescence, virility*, and *old age*. We shall, in a summary manner, examine the anatomical and physiological characters belonging to these different stages of life.

ARTICLE I.

Of Early Infancy.

This stage of life includes the seven first years after birth, the termination of which is marked by the second dentition. This is the most tender age, and consequently that which requires most care and attention.

The changes that occur in the organization at the time of birth, characterise a new life; the lungs, which

had so far remained passive in the economy, are roused to action, and fill with air by the alternate motions of inspiration and expiration—a motion, which terminates in death only. From this new function there results a conversion of venous blood into arterial. On the other hand, the foramen ovale (*trou de Botal,*) the arterial and venous canals are obliterated, as well as the umbilical arteries and veins; the *eustachian valve* propressively lessens, the pulmonary arteries develop themselves; and from that time, circulation assumes the new type which it is to retain throughout life, and the venous blood remains for ever insulated from the arterial. Finally, at this very epoch begin the functions of relation. As the infant experiences painful sensations from the contact of atmospheric air, and from the other bodies with which he comes in contact, he utters cries, moves his limbs, and thus proclaims his *civil rights:* his life, from that very moment, consists of all the functions we have described; the umbilical cord decays, drops off, and leaves an indelible cicatrix, the body grows, the internal sensations proclaim its wants, the nutritive substance is no longer supplied in a prepared state, the infant clings to the breast of the mother, who provides it with an aliment appropriated to the delicate state of the digestive organs. The parts become proportioned, with the exception of the head, which,

compared with the other organs, remains more voluminous; the face fills, secretions become active, ossification makes progress, the epiphyses develope themselves, hearing and sight begin to act their respective parts towards the fifth or sixth week.

At first, the infant manifests no moral faculties, but it is not long before he begins to know and love his mother, to experience sensations, and to manifest desires and will.

With respect to station and progression, these faculties unfold gradually; and it is the same with regard to the expressive phenomena, which primitively are restricted to gestures. Sleep, at first, is of long duration.

But the organization of the child is about to undergo another revolution, particularly in the digestive organs; in fact, it is not long before the mothers milk proves insufficient for the nutrition of the child. This function requires more substantial food; then the jaws are provided with teeth; the salivary organs develop themselves, and mastication takes place. The teeth (*first dentition*) first appear in the lower jaw, subsequently in the superior; the middle and lateral incisors appear next, and they are followed by the small molares, and canine teeth; finally, the second molares successively appear from the eighth month to the second year. The cutting of teeth sufficiently denotes, that the aliment must be changed, that both

nutrition and growth require more substantial materials. The child, whose wants of food are urgent and frequent, seeks the food of the adult, whilst, at the same time, the organic functions become more powerful and more active.

It is during the earliest period of life that the child acquires an astonishing degree of knowledge, his senses by degrees open to him the exterior world, and teach him how to act upon the surrounding bodies, his intellect is unremittingly active; thus we remark, that at this stage of life, the anterior part of the brain acquires a considerable degree of development. But if at this age the mind is remarkable for its aptitude and activity; it is true that the circle of ideas would be extended without order and much profit, if education did not give them a useful impulse by submitting them in a successive order to the different actions of the intellects, to *comparison, reflection, reasoning, judgment,* &c. Man is readily modified in his early infancy, when his organs have not had time to contract habit, when they have received transitory impressions only, and when they await in some measure, the impulse of a director.

ARTICLE II.

Of Early Infancy.

This stage generally extends from the second dentition (which commonly begins during the seventh year) to the first symptoms of puberty, that is to say, to the fifteenth year. This epoch is marked by the general development of the body, the progress of which seems somewhat slackened on account of the second dentition, and the unfolding of the genital organs.

The loosening and shedding of the first teeth warn us that an important change is about to take place in the apparatus of mastication ; the germs of the second dentition unfold and ossify; next, from the age of seven to eight years their irruption takes place, and is continued nearly in the same order as in the first teeth; the alveolar processes gradually extend to make room for the second teeth, and two large molares, which did not exist previously. The face at the same time expands, and the features present a different physiognomy.

The organic functions at that age, retain all their energy, the body considerably increases in stature, but it generally loses somewhat of its fullness, the senses are most active, the intellectual faculties are more intense, the sensations of morality unfold, and are for

the future to act as guides throughout social life, by instructing the individual in the duties he has to perform; the phenomena of expressions present a degree of vivacity that denotes how deeply the impressions have been received, and the utmost energy in the intellects. Finally, towards the close of this period, some changes occur in the genital organs, and these are the forerunners of a further change.

ARTICLE III.

Of Adolescence.

During this third period of life, which is marked by puberty, and, in our climates extends from fifteen to twenty-five in man, and from fifteen to twenty-one in the female, the body completes its growth and its organization; the distinction between the sexes becomes striking, and the genital parts fitted for generation.

The two sexes, previously indistinct as it were, by their physical attributes now assume their respective and distinctive characteristics. Man presents a slender and tall stature, his complexion becomes darker, his skin, robbed of its youthful appearance, is covered with hair, particularly over the genital parts, in the axilla, and over the anterior region of the chest; at the same time the beard grows, the muscles project,

the splanchnic cavities, as well as the organic apparatus, acquire due proportions; finally, the sexual parts increase in bulk, the penis lengthens, and the testicles also partake of the improvement.

In the female, on the contrary, the skin retains that softness and delicacy which it presented during infancy. It even grows whiter, fulness of habit succeeds, every form becomes rounded and graceful; the cheeks display animation, the chest rises, the breasts swell, the hips and the pelvis widen, the genital parts unfold and cover themselves with hair.

In both sexes the thymus and the capsulæ renales become absorbed, ossification is completed, suddenly the larynx assumes considerable increase, the glottis lengthens and widens, as has been clearly demonstrated by Professor *Richerand*; finally, the maxillary, frontal, and sphenoidal sinuses develope themselves.

Such remarkable modifications in organization must, as a natural consequence, occasion some change in the functions; in fact, at this stago of life they have attained their utmost development; digestion is rapid and easy, respiration deep and free, the blood is propelled with energy to the parts; every thing concurs to prove the utmost degree of vitality in the organs; the follicular, cutaneous, and genital excretions have a strong odour, the benzoic acid of the urine is now succeeded by urea.

At this blooming stage of life, sensations have at-

tained their utmost degree of nicety, perceptions are clear and prompt; but the ideas succeed each other with too much rapidity to allow of being matured; the imagination outstrips reflexion and reasoning, and its excessive vivacity often leads into error. Imagination begins its most brilliant era, and its energy is still increased by the burning desires which are about to unfold, and to impress a new character on the whole organization. At first, undecided, and without any apparent tendency, the desires we are alluding to momentarily stamp every function, every motion, and even every determination, with a character of langour and indecision, and the mind becomes unsettled; but these desires soon become very expressive, and soon give birth to the most universal passion—*to love.* This want, till then unknown, marked in man by audacity and violence, in the female by modesty, coquetry, and a desire of pleasing, coincides with the unfolding of the organs of copulation, which are observed to become endowed with remarkable sensibility, and under the slightest stimulating cause to enter frequently into a state of erection; from this very moment the secretion of semen in man, and the menstrual discharge in the female take place, and openly proclaim that the organs of reproduction are fit to fulfil their respective offices. At this epoch, the uncertain and languid state of the functions disappears, and these latter seem to receive from the activity

of the genital organs, an additional degree of energy and increase.

ARTICLE IV.

Of Manhood.

During the adult and virile stage of life, which includes with respect to man from twenty-five to sixty and with regard to the female from twenty-one to fifty,' the body continues to increase in corpulence, the whole organization tends towards perfection, the functions are in their utmost plenitude, and we find them in that state we have described in tracing their history. It is at this epoch, that each individual assumes a particular physiognomy; that idiosyncrasies develope themselves, and that the body yields to the power of habit. Every individual part has acquired its full degree of strength and of condensation; thus then, organs are more voluminous and more resisting, they have attained their summum of power, and admit of longer continued exertions; the functions without having been in the least robbed of their nice delicacy, have increased in vigour and extent; and it is particularly remarkable in the intellectual operations, which admit of a longer continued application. At this period of life, man possesses, in common with the most eminent qualities of the heart, all the mental powers of mature age; love is a powerful motive

to his actions, the enticement of the most vivid pleasures draws him towards the companion who shares his desires and feelings, and induces them to join hand and heart in the ties of matrimony.

But love soon ceases to be the ruling passion: the desire of glory, of riches, of honours, supply its place. The want of connection between the two sexes is less irresistible, and we very soon witness with sorrow and regret, the scarcity of erections, the flaccidity of the penis and of the testicles, the softness of the breast and nipple, the lenghening of the labia and nymphæ, which become flabby, and are pendulous; every thing in short, warns us of the approaching decay of virile age. At the same time, appetite decreases, the teeth begin to drop, never to be reproduced; digestion becomes languid, and every organic function loses its activity; the sensations are less delicate, impressions less vivid, the operations of the mind slower, except judgment, which increases in a proportional ratio with age. Finally, the hair grows white, the secretion of semen diminishes, menstruation becomes irregular and ultimately ceases. This period, unattended with danger for man, is frequently fatal to females, and more or less endangers their existence: this accounts for the name of *critical age*, having been given to this stage of life.

ARTICLE V.

Of Old Age.

Old age, the last stage of life, is characterised by a total cessation of the generative faculty, by the decrease of the body, the progressive decay of the organs, and also of the physical and moral powers.

Gradually as man approaches towards this last period, the body stoops and bends under the overwhelming weight of years, his skin becomes wrinkled, thin, dry, and harsh; the cheeks sink in, the eyes shrink within their sockets, and in consequence of the absorption of fat, the chin and nose become projected, and are approximated by the fall of the teeth; the appetite gradually decreasing, is sometimes completely lost; digestion is slow and painful; the large intestine, affected with atony, frequently suffers itself to be distended with dry and hardened alimentary residue, and defecation thus becomes such an arduous affair, that it occupies the whole attention of the decrepid subject; the parenchyma of the lungs is altered, it is less vascular, the bronchi frequently are ossified and dilated, respiration slackens, panting becomes frequent, the cavities of the heart either contract or dilate frequently, even their parietes are affected with hypertrophy; the arteries ossify, the veins dilate, cir-

culation has lost its energy, the pulse is slow, irregular, intermittent; the blood ascends against the laws of gravity with difficulty, and stagnates in the most declining parts; the secretions diminish, the reservoirs empty slowly, and with difficulty only their contents.

The enumeration of the deteriorations which befal the functions of relations is not less afflicting; the senses are robbed of their acuteness; they are blunted, and ultimately completely obliterated; the dry and rough skin of the hand no longer gives pleasing impressions; the humours of the eye soften, and loose their refractive powers, or again they become thick and opaque; the alterations of the ear, which are not so easily ascertained, are sufficiently demonstrated however by the difficulty of hearing, which is frequently owing to a mass of hardened cerumen obstructing the external auditory duct; the brain is softer, the grey substance paler, the membranes generally thickened, they even sometimes present either cartilaginous or osseous points, circulation in the brain has lost its energy, the blood stagnates in the dilated vessels; the nerves harden, and become thinner; perceptions are slow, memory is lost, attention forsakes external objects to devote its remaining power, exclusively to animal wants; imagination is for ever chilled; and, finally, even judgment forsakes the helpless and decrepid old man, and plunges him into a state of second infancy.

The qualities of the heart are less fugitive than those

of the mind, and if some vanish gradually as decrepitude makes progress, there are some which seem to survive the general ruin of the organs; friendship, for instance, may seem to have lost a part of its energy, but the decay only affects the expression, the sentiment remains genuine and true; the love which the parent bears to his offsprings, the feeling of gratitude, and of respect we are inspired with at the very thought of our Maker, never forsake man but with life, and attend him to his very last gasp.

With respect to motions, they become slow, undecided, and are soon lost in old age; at this stage of life the bones are thick, their tissue hard and compact, but their cavities are much dilated; they are not so heavy as in the adult, the articulations are stiff, the muscles flabby, thin, and pale; finally, the expressive phenomena soon partake of the general disaster, the voice is harsh, tremulous, and gradually sinks away.

The sexual organs partake of the general decay, and display the utmost degree of flaccidity; from this time also they are divested of the power of action: hence, the wise man will submit to the general law of nature. But if, mistaking for wants the deceptive illusions of his mind, or if attempting to create fallacious desires by shameful means, the imbecile old man seeks in the arms of love, for past enjoyments, he is likely to meet, in the attempt that exceeds his powers, with a severe punishment for his amorous delirium.

Such is the abridged picture of the remarkable epochs man presents during the course of his existence; we have observed in his organization, and in his functions an uninterrupted series of modifications and changes, which, during life, mark distinct periods —*the ages.* As far as the nature of the object would admit, we have referred them to certain periods. But we should be well guarded against attaching too much importance to these references. In the first place, because they do not admit of accurate calculation; secondly, because the different phases of life succeed each other with more or less rapidity, according to climates, to the manner of living, to moral affections, and to a number of other concurring circumstances. We are, for instance, perfectly aware, that puberty begins early in tropical climates, and is more tardy in the frigid regions. It is said, that *Bebe,* the king of Poland's dwarf had attained the utmost degree of decrepitude at the early age of twenty-three, &c.

CHAP. II.

OF INDIVIDUAL DIFFERENCES.

Organization is the fundamental character of every living being. But, in each subject, organization presents a number of individual modifications, which are marked by considerable differences in the phenomena of life, for which the physiologist has to account, as far as they are compatible with the healthy state. These differences, or individual distinctions, with respect to man, may be referred to the following: 1st. One or more organs may have their functions stamped with a character of irregularity at times very remarkable, without however there resulting from this any general influence over the organization in general, these modifications constitute what are called idiosyncrasies. 2dly. Other and more considerable causes may act upon the apparatus of one of the principal functions, and mark the whole economy with a peculiar moral

and physical character, whence results what have been termed *temperaments*. 3dly. Or again, these individual distinctions result from the repeated action of external agents, and from the unremitting exertions of the same organs. In this case, they consist of acquired differences, called *habits*. 4thly, and finally, There are individual organic modifications, which seem linked with the primitive organization of man: from these result the distinction between the different *human races*. We shall devote a particular chapter to each.

ARTICLE I.

Of Idiosyncrasies.

Taken in the etymological sense, the word idiosyncasy is synonimous with temperament. But, according to its most common application, it expresses an individual difference, either acquired or congenital, consisting of an irregularity in a function, generally restricted to one single organ, the function of which contrasts in the most singular manner with that it was primitively intended for.

These unaccountable anomalies have, undoubtedly, fallen within every body's observation; for there is not a single function which does not frequently afford an instance of these irregularities; with respect to these functions, we shall select the most remarkable.

Digestion.—It is reported that a friend of *Tissot*, otherwise enjoying perfect health, was in the habit of vomiting after having taken sugar. In this respect we are aware how much taste varies; thus some persons eat with delight the most disgusting substances, and frequently, such food as is of the easiest digestion for the generality of persons is, indigestible to others, &c.

Absorption.—Absorption presents as many peculiarities as the preceding function; for instance, the promptitude with which certain persons absorb, contagious, deleterious, putrid miasma; whilst others, submitted to the same influence, are not in the least affected by them.

Respiration.—With respect to this function, we are aware of the remarkable differences existing between men. Some have it naturally short and accelerated; with others, it is slowly effected. A person, with whom I am acquainted, although enjoying an excellent constitution and perfect health, is involuntarily led to sigh deeply after every third or fourth inspiration.

Circulation.—This function also presents to observation a number of remarkable irregularities. In fact, innumerable differences are observable in the quickness, duration, and fullness of the pulse. It is asserted that the pulse of *Napoleon* only beat forty-four times in a minute.

Assimilation, *Calorification*, and *Secretions*, are liable to similar irregularities. A man, for instance, who

enjoys all the sweets and comforts of life, will remain emaciated, and present a spare habit; whilst another acquires strength and corpulence, even on being denied the most common necessaries of life.

Sensations.—Idiosyncrasies are particularly remarkable in the functions of sensibility,—what eccentricities do we not observe amongst men with respect to the senses? The feel of velvet produces nausea and syncope with some persons, and that which is the most savory dish to one is unbearable to the palate of another: odours, delectable to some people, prove most offensive to others. The native of *India* holds the smell of meat in abhorrence: *Haller* hardly perceived the effluvia from the most putrid subject; *Gaubius* instances a man who could not withstand the emanations from a female; *assafœtida*, the *chenopodium vulvaria*, convey the sweetest fragrance to some of the most affected young coquets; a young man is seized with an epileptic fit at the sight of rouge; a celebrated English chemist cannot possibly distinguish scarlet from nitric acid. The sense of hearing is not less remarkable for its peculiarities: *I. I. Rosseau* mentions a young man who was afflicted with retention of urine on hearing the bagpipe; only compare the effect of harmony, on a clown, with that it produces on a professional musician, &c.

The cerebral functions have also their anomalies, we know how widely men differ with respect to the nature and extent of their intellectual faculties.

Finally, in the functions of generation similar peculiarities are observable; some individuals seek in copulation the most lively enjoyments, whilst others find none. One female will be blessed with a blooming and numerous offspring; another, in spite of the most vivid desires, the most repeated and best calculated attempts, will leave a title and fortune extinct for want of a heir.

These irregularities are perfectly known by their effects; but, in common with a multiplicity of other natural phenomena, their nature and origin are involved in the utmost obscurity; however, they are generally referred to a peculiar structure of the organs, and to their respective kinds of sensibility.

ARTICLE II.

Of Temperaments, or Constitutions.

Under the name of temperament are understood the individual differences consisting of diversities of proportions and activity in the organic apparatus of the human body, capable of modifying in a sensible manner the whole organization, compatible however with the preservation of health and of life.

The ancients considered the human body as formed by an association of four elements, *heat, cold, dryness,*

and *humidity*, united by four different combinations, to each of which, according to their opinion, corresponded the predominance of one of the four humours, the *blood*, *bile*, *atrabile*, and *phlegm*, which they distinguished in the human organization. In consequence of this idea, they first established four principal temperaments, the *plethoric*, the *bilious* or *choleric*, the *atrabilious* or *melancholic*; finally, the *pituitary* or *phlegmatic*. Next, from the combination of these, they drew the *mixt* temperament, and the *temperated* was the result of their perfect combination. They depicted, with so much eloquence, and in such vivid colours the features peculiar to each, that their doctrine lasted till lately, with every appearance of truth.

But, in the first place, what are these four elements, heat, cold, dryness, and humidity—if they are any thing else than the products of a poetical imagination? In the second place, what are atrabile and phlegm?—Where are these humours? Who has ever seen them? Modern physiologists had admitted of the plethoric, bilious and phlegmatic temperaments of the ancients, referring them to a preponderance of the vascular, hepatic, and lymphatic systems; subsequently they added two more, the *nervous* and the *muscular*, or *athletic*.

Hallé, viewing the proportion of the general systems diffused throughout the economy, their dis-

position in the different regions of the body, and the predominance of the most important organs, divided temperaments into *general* and *partial*. Thus, from the reciprocal redundance of the vascular and lymphatic systems, or from their median proportion, he deduced three general temperaments, which correspond with the plethoric, bilious, and pituitous of the ancients: Next, studying the nervous system in reference to its susceptibility,—in the duration of the impressions this system receives, and the promptitude with which they succeed each other and associate, he demonstrated that these dispositions give rise to the preceding temperaments, and that they impress upon them the various modifications. Finally, considering the last general system, the muscular apparatus, he grounded the *athletic* temperament, and the *convulsive nervous*, where there existed a coincidence of considerable excitability. With regard to the partial temperaments of *Halle'*, they are owing to—1st. The proportions assumed by the general tissues in the different regions of the body; 2dly, And to the predominance of cer- organs. *Halle'*, with respect to these, mentions three principal ones. The *pituitary*, characterised by a redundant mucous secretion; the *bilious*, properly so called, marked by a superabundant secretion of bile; and, lastly, the *melancholic*, arising from a particular state of the hypochondriac viscera, and of the epigastric nervous centres.

Finally, *Rostan* has given a still more physiological history of temperaments, taking for their basis either the predominance or the inferiority of the organic apparatus which fulfil the most important functions in our economy.

1st. *Temperament in which the Digestive Organs predominate.*—The subject, in whom this apparatus predominates, is remarkable by the sharpness of his appetite, the powers of his gastric organs, and the promptitude with which digestions are effected; a part of the bile, the secretion of which is very abundant, is returned to the circulation, stimulates the internal organs, and spreads a particular hue over the whole surface. The subject, thus constituted, is no less remarkable for the development of his intellectual faculties than for the vivacity of his imagination; he is a stranger to moderation; he performs with violence and obstinacy what he undertakes with audacity; his passions are over-ruling. This temperament belongs to tyrants, to men of genius, to benefactors, to conquerors, &c.

2dly. *Temperaments in which the Organs of Respiration and Circulation predominate.*—This temperament is characterised by the development of the chest, and of the thoracic organs, the energy and activity of their functions, the fulness and quickness of the pulse, the organic functions are performed with ease, the motions are prompt and natural, imagination is less profound but is animated and lively, the mind is remarkably

mobile, consequently not calculated for meditation; the passions are more manageable, the impressions succeed each other with rapidity, and only leave transitory traces.

3dly. *Temperaments in which the Brain and its Dependencies predominate.*—In this constitutional temperament, life seems to have forsaken the vegetative functions to take shelter in the nervous apparatus; the body is slender and emaciated, the skin dry and cold, the countenance melancholic, digestion is slowly effected with difficulty only, the pulse is feeble and slow, the motions are characterised by circumspection; the sensations, on the contrary, are quick, the passions remitting. The individual, thus organized, has a gloomy and wandering imagination, but constantly active, he is endowed with a wonderful penetration of mind. When this constitution is united to the first, it gives birth to men who astonish the universe: *Pascal, Rosseau,* &c.

4thly. *Temperament in which the Apparatus of Locomotion predominates.*—In this constitution, on the contrary, the organic functions are most energetic, the bones are much developed, the muscular projections are strongly marked, the chest wide, the shoulders broad, the muscular fibres dense and compact, admit of the most violent efforts, but as a compensation for these

advantages, the sensations are obtuse, the mind heavy and narrow,* the passions cool, &c.

5thly. *Temperament in which the Genital Apparatus predominates..*—This temperament is characterised by a remarkable development of the genital parts, and the activity of its functions, by amorous desires incessantly renewed, a lewd imagination, frequent erections, a thick and brushy beard, a tolerable degree of corpulence, a base and sonorous voice. This amorous exaltation is more frequently met with in females than in man; it generally co-exists with a remarkable activity in the digestive apparatus; without this last condition this temperament unavoidably leads to premature exhaustion.

6thly. *Temperament Characterised by the Atony of all the Organs.*—The body is heavy, pale, and remarkably corpulent, the features are void of expression, the motions slow and difficult, digestion requires time and is laborious, circulation without energy, the pulse soft, and very compressible. The moral faculties rather inactive; the sensations obscure; the mind correct, but deficient in vivacity and penetration. The subject is indolent and, without passions of the temperament, and not very fit for venereal pleasure.

7thly. Finally, from a suitable development of the

* There are, however, some exceptions to this: *Plato*, for instance, after having been victorious in the Arena, became the greatest genius of his age.

different organic apparatus coinciding with a proportional energy in the nervous systems, *Rostan* deduces what he terms a *strong constitution*. Well understood, however, that by this denomination he does not allude to muscular power, which characterizes the athletic constitution, but to that force by which the stability of health is kept up, by opposing the morbid causes which incessantly tend to alter or to ruin the edifice. From inverse circumstances we of necessity infer an opposite constitution. It is by studying successively the different functions, that we are enabled to judge of the energy, and of the proportion of their organs, consequently of the degree of energy and of debility of the constitution; for every individual is possessed of one peculiar to himself, and this is again an additional source of individual distinctions between men.

All the individual differences we have just been studying, may either be innate or acquired: undoubtedly parents do transmit their physical and moral resemblances to their offsprings, and for this reason, some of their intellectual and morbid dispositions, &c. Undoubtedly also children at birth are endowed with a particular organization, from which frequently results their future temperament, and the force of their constitution; but it is equally correct to say, that this primitive organization may be modified under the influence of external circumstances, in such a manner as to receive a particular character, new dispositions, &c.

In fact, what differences do we not remark between individuals who inhabit the various parts of the globe, from the tropical climates to the polar regions. Between such as live in plenty, and those who cannot obtain even the necessaries of life; between the man who leads a social life, and him who wastes his existence in riot and debauchery; between the active man and the idle, who, living in a disgraceful inactivity, condemns his organs to eternal rest; between him whose moral and intellectual faculties have been cultivated, and the unfortunate wretch who has been denied the benefit of education; finally, between those who enjoy the sweets and happiness of liberty, and those condemned to servitude and slavery?

ARTICLE III.

Of Habits.

The name of habit has been given to modifications of functions, which constitute new organic law, quite as influential as the natural power, and which results from a repetition of actions or sensations long continued.

The economy of man, more than that of any other animal, yields to the influence of habits, and this particular condition is indispensible, when we consider the part he has to act in the universe. In fact, Man being

calculated to inhabit every part of the globe, required great flexibility of organization to accustom himself to the various climates, and to the diversity of food they produce; on the other hand, doomed to live by the product of his own industry, and to make society at large partake of the benefit, it is in a great measure to the remarkable flexibility of his organs that he is indebted for the superiority he acquires in the arts and sciences.

The different ages are not all equally influenced by habits; easy as it is, for instance, for children and females to contract new ones, the hardened organization of man in years equally resists the introduction of a new habit in the manner of acting.

Habits have a considerable sway over every function, we shall therefore give each of them a cursory glance. And, to begin, who is not aware how much digestion is under the influence of habit: Habit regulates the hours for the return of appetite; habit also becomes tyrannical with respect to certain food and to certain drink, it regulates the taste and quantities; it is through habit that indigestible food, even deliterious substances, no longer produce their usual effects. Every body is acquainted with the anecdote by which we are informed, that *Mithridates* could not destroy himself by the most active poisons, on account of his being accustomed to their use. The numerous tribes

of the East swallow with impunity considerable quantities of opium; and experience daily proves to the physician, that his remedies will cease to act if the dose is not gradually increased, provided their use has been too long continued. Respiration is not less influenced by habit: it is thus that scavengers and nightmen breath an atmosphere that would suffocate any other man. I have heard the remarkable fact, that a prisoner, after having been confined for thirty years in an unhealthy dungeon, was taken ill on being discharged, and only recoverd his health by returning to his infected cell.

It is over sensations particularly, that the influcnce of habit is considerable. We know how much the impressions of cold and heat can be modified; how much habit developes the delicacy of touch, and of the other senses: a blind man has been known to describe the precise colour of a piece of cloth, respecting which, clear sighted persons disagreed by candle light. Taste and smell are not less susceptible of being improved by habit; what differences do we not observe between men in this respect, in the delicacy of the palate and that of the nose? The very same thing with regard to the ear. Only look at the Indian, he hears the noise of his enemies at an astonishing distance; or the musician, who feels shocked at the slightest false note in the midst of a considerable orchestra; sight also is susceptible of being perfected. But if habit

extends the sphere of our senses, most frequently also habit will contract it by blunting them; it is thus that touch looses its precision by the painful manual toils of the labourer; that a savoury dish produces no sensation on the palate impaired by the immoderate use of strong spices; that a man in the habit of using snuff, is compelled gradually to increase both the strength and the dose; that hearing becomes hard by the habit of noise, and the sight is impaired when the eye is accustomed to too vivid a light.

Voluntary motions are influenced by habit in a most remarkable manner: by habit they acquire the most astonishing precision and agility; by habit again the muscles admit of displaying astonishing efforts. The duration of sleep also is frequently influenced by habit.

Finally, we again remark similar influence over the functions of generation. *Richerand* mentions the remarkable instance of a shepherd who, during upwards of forty years, successively made use of the hand, of a stick, and finally, of a sharp instrument, to procure himself thc voluptuous sensation which generally attends the ejaculation of semen, and which in this subject was gradually lost by masturbation, which he used to repeat several times a day. Onanism, at other times, will produce the reverse, it plunges the sexual organs in such a degree of excitation that the slightest friction

produces the ejection of the semen. Finally, we are perfectly aware, that the habit of connubial pleasures enables us to withstand their excess.

From what precedes, we see that *Bichat* has made a mistake by pretending that habit extended its influence no farther than over the animal functions; for it is now placed beyond a doubt that the vegetative functions also obey its laws; this besides might have been easily foreseen on reflecting that vegetables themselves are submitted to the influence, the habits of the spots, of localities, &c.

Habits we have said result from a continuation of actions or of impressions; this, in fact, is what we have been able to remark, in the analysis just given, since at times it was the actions, at others the sensations which we have found modified by repetition.

The general effect of habits, is to rid the functions of obedience to the natural organic laws, and to assume a tyrannical sway over human actions from which he cannot rid himself without incurring serious accidents; this accounts for the name of *second nature*, which has been given to habit. With respect to the immediate effect of habits, it has generally been repeated after *Bichat*, that they *blunt the sentiment*, and *perfect the judgment*. However, if it be true, as we have seen, that they gradually blunt the sensations, it has also been demonstrated to us, that they may exalt them to excess; only let us refer to the Indian who

hears at an astonishing distance, and the musician who leads a great orchestra; *Richerand* answers to this, that it is not the ear that perceives the sound, and that the impression this organ receives should only be considered as the cause of the sensation, the perception of which exclusively belongs to the brain; but can this objection be opposed to the observation of that prisoner who perfectly distinguished objects in his dark dungeon, and to whom daylight had become unbearable? *Rostan*, *Adelon*, and other physiologists admit, 1st. That stimuli successively increased, blunt the sensations; 2dly. That moderate impressions extend the sensibility of the organs, and exalt it to such a degree, that strong impressions become painful; 3dly. That the organs loose or acquire aptitude or energy according as the repetition of their acts is more or less continued, and requires from them more or less activity.

It is impossible for man to resist the power of habit, for there are some to which he irresistibly submits; in these he generally finds laws, which regulate and facilitate his life; whilst there are others which are solicited by social circumstances, and which most frequently are pernicious; these he ought to avoid as much as lays in his power, or he will incessantly create to himself new wants, which he must either indulge, or be the sufferer.

ARTICLE IV.

Human Races.

The distinction between the human races is grounded on the generic differences in the primitive organization of man; their study exclusively belongs to natural history, thus shall we restrict ourselves to mentioning here the opinions of the most celebrated naturalists on this interesting subject.

Buffon acknowledges but one single human species; he says, all the races are linked together from one climate to another, and that the particular characters which have been pointed out, are the result of exterior influences; however, specics have been admitted of, not quite so distinct as in animals, but what has been called *races*. *Cuvier* mentions three: the Cancasian or white, the Ethiopian or black, and the Mongolian or yellow.

1st. *Cancasian Race.*—This race is the handsomest and the most perfect: it is remarkable for its oval head, and its facial angle, which is very large. This race of men inhabits Europe, Syria, Persia, Asia Minor, the Peninsula, this side of the Ganges, Arabia, the South of Africa, the north of Mount Atlas, &c.

2dly. *Ethiopian Race.*—This race, by some particular features in its organization, approaches the monkey.

The forehead is depressed, the cranium has less capacity than in the former race; the whole face is remarkably developed, the jaws project, particularly the inferior, which is very much extended; the inter-maxillary bones are seen to exist in the embryo, which is never the case in our race; the lips are thick, the cheek bones prominent, the zygomatic apophyses much arched, the nose flat, the hair curly, wooly, and very fine; the skin, the blood, the cortical substance of the brain, and some other internal parts, are black. This race is not so generally diffused as the first, and inhabits the whole part of Africa, included between Mount Atlas and the Cape of Good Hope.

3dly. Finally. *The Mongolian Race, or the Tartar,* has an olive complexion, the hair and beard thin, short, and black, the head is large, the cheek bones very projecting, the eyes placed obliquely. This race inhabits all that part of the globe, included between the East of the Caspian Sea, and of the South Sea, China, Chinese Tartary, Siberia, Japan: it is the most ancient race.

To these three races, *Lacepede* adds two more: the *American,* who have a copper coloured complexion, these men inhabit South America; and the *Hyperborean Race,* consisting of the Laplanders, Greenlanders, the Samoiede, &c. The *Albinos,* the *Cretins,* and the *Cagots,* are generally considered as infirm subjects.

CHAP. III.

OF SYMPATHIES AND SYNERGIES.

In the particular history of the functions of man, we have pointed out the principal connections which he establishes with external objects in order to insure his existence. We shall now briefly examine the numerous and diversified connections which link together the different parts of his organization; we are already acquainted with the connections between the functions; we know, for instance, that the secretion of bile is intimately connected with digestion, that a similar connection exists between respiration, circulation, nutrition, and secretions, that the action of the senses is connected with the functions of the mind, &c. We have now only to study sympathies and synergies.

The name of sympathy has been given to involuntary modifications, which supervene in one or more distant organs, in consequence of an impression re-

ceived by another, without this modification admitting of being attributed to functional connections of the parts.

Barthez was the first who distinguished sympathies from synergies, and he included under this last expression the concurrence of simultaneous or successive actions of the different organs for the performing of a function; for instance, he considered the contraction of the diaphragm and of the abdominal muscles in defecation, as a synergy. *Richerand* sanctioned this distinction; *Adelon*, on the contrary, considers it as being unimportant; he pretends, that, in both cases, the connection is similar in its nature, and proceeds from the same cause. I am far from coinciding with this physiologist in opinion; most undoubtedly he is correct in throwing this distinction aside with respect to the pharynx in the act of deglutition; for, as soon as the aliment has crossed the isthmus of the throat, the pharynx sympathetically contracts; that is to say, independent of any interference of the will. But what similitude can there be found between an action, purely voluntary, of the abdominal muscles in defecation, with the irresistible influence of the retina over the iris, &c.? What sympathy admits either of being reduced or stiffled at will?

Sympathies are remarkably numerous, their end is not less varied, let us give them a moment's consideration:

1st. They are shewn amongst the different parts of the same organ; thus, for instance, the iris contracts or dilates as the rays of light which strike the retina are more or less vivid; undoubtedly there exists between the different parts of the ear, similar sympathies, which are concealed from us on account of their being deeply situated. In some cases, sympathies manifest themselves in organs very distant from each others, and belonging to the same apparatus; such are the connections which cause the breast to sympathize with the uterus.

2dly. Frequently we detect sympathies between different parts of continuous membranes; these are the *sympathies of continuity of Hunter*. It is thus that the uvula, tasting as it were, the alimentary substance, prepares the stomach to receive it with more or less pleasure, or to refuse it. It seems that all the parts of the digestive membrane possess similar reciprocal connections.

It is by sympathies of the same order that the presence of worms in the intestines occasions an itching in the nose, that a calculus in the bladder, is attended with a particular sensation, troublesome, painful even, in the fossa navicularis, and in the glans; hence, that an irritating substance applied to the orifice of an excretory canal, extends its influence to all its ramifications, &c.

3dly. At other times, sympathies manifest them-

selves in parts immediately continuous; the blood, for instance, on being poured into the cavities of the heart produces on the membrane by which these cavities are lined, an impression which instantly stimulates to action the fleshy layer it lines. By a similar action, the disagreeable impression of the stomach is extended to the muscular coat, and to the abdominal muscles, and solicits vomiting; that, the presence of food in the digestive tube is productive of the peristaltic motions in this canal, and much more energetic than any that could be produced by direct irritation, as has been proved by the experiments of *Bichat* and *Nysten;* that that irritation in the fossæ nasales occasions sneezing, that the introduction of a foreign body in the bronchi is productive of coughing, &c. Such are the sympathies called by *Hunter*, *sympathies of continuity.*

4thly. Organs possessed of similar structures and functions, appear to be intimately linked together by sympathetic connections; such sympathies are very plain in the morbid state. It is thus, for example, that we daily see inflammation forsake one of the amygdalæ to affect the opposite gland; we know with what promptitude rheumatism flies from one articulation to another. It is not uncommon to see this affection, which at first had fixed upon a muscle, invade

with astonishing rapidity the whole of the apparatus of locomotion.

The case we are about to relate is the most extraordinary I have ever heard of in this kind of sympathy: *Barthez* mentions, after *Zenon*, that a blister applied to a paralysed limb, only produced its customary effect on the corresponding limb of the opposite side. Some physiologists refer to these same sympathies, the harmony existing between the motions of the eyes.

5thly, finally. There are sympathies which radiate from one single organ over the whole of the economy, or reciprocally. Let us suppose, for a moment, the blood deprived of its nutritive principles by a somewhat protracted abstinence, the organs no longer finding a supply to make up for their inremittent losses, suffer, become languid, it is from the stomach they replenish, and it is that organ that warns us of their wants; the stomach is no sooner filled, and hunger satisfied, than that the whole organization manifests additional energy, even previously to digestion having commenced.

The genital apparatus is another and not a less fruitful focus of general sympathetic irradiations, all its actions extend throughout the economy, it seems to hold under its dependence the organism of the female, as the ancients had already remarked: *uterus est animal vivens in muliere*. The cerebral functions are in the same case. Only consider the man whose mind

is seriously taken up, all his fuuctions are languid, his wants are silent; subsequently see the same subject indulging in innocent pleasure and amusement, the functions suddenly reassume their usual energy and activity, his wants become vivid and urgent. The passions also are productive of general sympathetical effects; if they are mild and tender, the body experiences an expressible comfortable state, the soul is satisfied, the mind brilliant; we observe the reverse when passions are violent. Every one is acquainted with the old adage, *Il se sèche d'amour*.

The sympathetical phenomena vary according to individuals, according to the preponderance of such or such an organic apparatus in the economy. For instance, if it be the brain, the digestive, or genital organs, that predominate, the sympathies in either of these cases will assume particular characters; finally, sympathies also admit of a variety in intensity and extent, by the more or less considerable activity of the organs, or by the morbid state; in the latter case, the most obscure sympathies become striking, and every organ may become the focus of general irradiations (*fevers*); but in every case the intensity of the sympathetical mischief generally varies, as may easily be supposed, according to the nature and intensity of the injury, and also according to the organization and natural activity of the diseased organ.

It should be observed, that in every sympathy two

things present themselves to our consideration, their focus, or point at which they originate, and the limits of their irradiations. This is what *Bichat* termed *active* and *passive* sympathies; erroneous expressions, calculated to convey incorrect ideas.

Now, what is the agent in virtue of which sympathies manifest themselves? In a word, what is their instrument? Physiologists widely differ in this respect: *Whytt* refers sympathies to the soul; *Roux* views them as independent of organization, he considers them as the result of vital properties, consequently he grants them actual existence: *Bordeu* makes them derived from oscillatory motions in the cellular tissue; other physiologists have endeavoured to explain them, through the means of the vascular system; but the hypotheses brought forward in this respect fall to the ground. Finally, a few of the ancient authors, and most of the modern, attribute all sympathies to the nervous system. This apparatus is, in fact, the most generally extended, all its parts tend to a common centre; finally, its actions are as quick as thought: such undoubtedly are the most favourable conditions to give a satisfactory explanation of the sympathetical phenomena.

The nervous system establishes sympathetical connections in two different manners—1st. Either the organs between which sympathies take place, communicate together by means of ramifications from the same nerve, or by anastomosis; 2dly. Or the sympathetic

irradiation tends to nervous centres from which they are subsequently reflected over one or more organs.

From these two modes, or sympathetic conditions, results—1st. The *direct sympathies*, which *Vieusseus*, *Meckel*, and *Boerhaave*, considered as being the only ones; 2dly. The *cerebral sympathies*, considered by *Willis*, *Haller*, *Broussais*, *Georget*, and *Adelon*, as the most numerous.

The knowledge of sympathies is of great importance, and in practice we daily find opportunities for their applications. It is by sympathies, in fact, that we are frequently induced to apply medicaments over such or such a part, inasmuch as we observe this part to sympathise with the diseased organ, &c.

Synergies differ from sympathies, inasmuch only as they are completely under the dependence of the will; they consist of simultaneous or successive actions, voluntarily directed towards the same tendency. We have witnessed the larynx irresistibly contract in deglutition, the iris also to contract independently of the will under the influence of too vivid a light, &c. We shall find, that it is no longer the same thing with respect to the action of the abdominal muscles in defecation, delivery, and the excretion of urine. When, for instance, the want of fœcal excretion becomes pressing after having been resisted for some time, the abdominal muscles are not observed to contract sympathetically, and in an involuntary manner; but what

may be perfectly ascertained, is that the stercoraceous matter is expelled by the single action of the rectum; and that, if yielding to a particular and pleasing sensation, which entices us to add auxillary powers, we generally associate with the former the action of the abdominal muscles, yet their contraction is in every case not the less dependant on the will: the same thing occurs with respect to labour: who is not aware, in fact, that the mother may retain the action of the abdominal muscles, at the moment the uterus contracts, is it not from this, that originates the custom of inviting the patient to *profit by her pains, not to spare nor to hold her pains*? Finally, it is in consequence of the will, that the abdominal muscles associate with the bladder, to effect the excretion of urine.

CHAP. IV.

OF DEATH, OF THE CADAVEROUS PHENOMENA, AND OF PUTREFACTION.

Nature having endowed man with the faculty of reproduction has been under the necessity of condemning him to die; our globe would be overrun with population arising from our ever increasing species, without the preconcerted and indispensible ravages of death. By death, is understood, a total and final cessation of the phenomena of organization, the harmonic assemblage of which, characterised life; it is the term of our terrestrial career. We distinguish two kind of deaths—the *natural* and the *accidental.*

1st. *Natural Death.*—In studying the different ages of man, we have seen organization attain through a series of periods, the most brilliant epoch of life, and

apparently remain for some time stationary; subsequently we have followed it through the phases of its decrease, and in this last period we have traced the progressive decay of the organs; we have seen that the functions become languid, and even completely disappear, and the rapid steps of decrepitude warn us of our approaching end; we have seen digestion no longer produce but a scanty supply of chyle, and that, imperfectly elaborated; circulation slackened, and reluctantly assisting in imperfect sanguification; the blood, chilled and impoverished from the fore-mentioned reasons, slowly and hesitatingly as it were conveyed to the organs, the respective vitality of which progressively becomes more and more languishing and precarious; long before this, the genital functions having been destroyed; the hardened senses obliterate every day; every faculty of the mind, and of the heart gradually vanish; the voice sinks, and ultimately dies away; the circle of our vital phenomena contracts more and more. Man, in this state, soon looses all self-perception, and from that very moment he exists for himself only; similar to the exhausted oak, he consumes the last drops of sap—the slightest commotion, the slightest shake will suffice to put an end to his existence, and deprive him of his last breath; but he still breathes; innervation, respiration, and circulation, prolong for a short time the existence of his inanimate frame, and seem to await the utmost degree

of exhaustion, by reciprocally supporting each other. Finally, one of these languishing functions yields and becomes extinct, instantly the whole edifice moulders into dust! Of these last roots of life, it is probable that nervous power first sinks, and from that very moment there is an end to the action of the lungs; finally, the blood being no longer admitted into these organs, accumulates in the right cavities of the heart, which dies last.

2dly. *Of Accidental Death.*—By accidental death, we understand that, which man meets with previously to his organs having undergone the regular process of exhaustion by the ordinary course of life. This kind of death is the most common in the present time, and its occurrence seems to be in a progressive ratio with the accumulation of ages; and as civilization makes progress, its causes, which are very numerous, might be referred to the following:—1st. Privation of air and of food; 2dly. The mechanical disorganization of the first apparatus of life; 3dly. The substances which, being admitted in the economy, destroy the organs, or the nervous action, the power of life—such are *poisons;* 4thly, finally, All those morbid actions which so frequently unfold themselves in our organs, either spontaneously, or influenced by natural agents.

From this remarkable variety of causes for accidental death, it will be easily conceived that the phenomena which attend it must be infinitely numerous.

At times, one of these causes violently acts upon one of the central organs, then death is sudden, or very soon follows; at other times, it acts with a kind of circumspection, as it were, the progress of the mischief is slow, the waste of the organs is gradually effected, and requires six months, a year, two years, &c. to produce premature decrepitude; death, in this case, is so much slower, as the afflicted organ is less essential to life.

Death, as we have said, is the final discontinuation of vital acts; but now what can be the cause of this cessation of life, or, in a word, what is the cause of death? When man sinks under the disorganization of one of the central organs, or subsequently to a complete disaster sympathetically produced in all the functions in consequence of the sufferings of an organ, undoubtedly in this case, there is nothing astonishing in death, nothing which the physiologist cannot account for. If, for instance, nervous power happens to be suspended or exhausted, either by a direct or sympathetic alteration of the nervous centres, by cerebral hæmorrhage, or by acute pain, it will be easily conceived how the loss of an important piece in the machinery must unavoidably lead to the ruin of the rest. That which happens in this case, is perfectly similar to what would occur with respect to a watch, if the main spring should happen to snap. The very same

thing will occur, but in a different manner, if the lungs or the heart chance to be obstructed in their functions. In the first case sanguification incomplete, or even interrupted, will only prepare for the organs a cold and impoverished aliment, which soon proves insufficient to stimulate the action of the nervous centres; in the second case, if the heart be the sufferer, the langour and obstruction of the action of this viscus will produce similar effects on the nervous foci, and on those of life, &c. In a word, there is nothing in accidental death that cannot most readily be accounted for.

Natural death, at a first glance, appears more extraordinary, and more difficult to explain; we shall see that it occurs by a progressive decrease of the four fundamental functions of life. In the last moments of decrepitude, appetite, which every day loses some of its activity, entirely ceases, or nearly so; the small portion of food which reaches the digestive tube, is but slowly and imperfectly digested, and a very small proportion of chyle, imperfectly animalized, is with great difficulty conveyed with the venous blood to the lungs; these organs, in which the ossified aerial tubes are frequently contracted, have lost a great part of their vascularity by the obliteration of their capillary vessels (as may be observed in the placenta, gradually as the moment at which the child is to enjoy a new life approaches,) and by a natural consequence of these changes *hæma-*

tosis is but imperfectly and with difficulty affected; on the other hand, the heart flabby and void of energy, feebly propels the blood to the organs. The ossification of the arteries and the obliteration of the capillary system, are additional causes for the languid state of circulation; the dilated veins loose their elasticity, and the return of the blood becomes more and more difficult and retarded; at the same time, the brain shrinks, the nerves harden and stiffen, consequently the activity of nervous influence progressively decreases, and life, which had long been in a languishing state, is ultimately robbed of its remaining energy. These four principal functions die away gradually, and hasten their ruin by reciprocal influences; finally, death supervenes, as has already been said.

Such evidently are the causes of natural death; they are, as we have seen, less obscure than has been generally professed. But what is perfectly unknown, and will most probably still remain unknown for a long time, is the causes of the succession of ages, of the numerous modifications, which the organization experiences during the course of life, in consequence of the series of deteriorations which ultimately terminate in death. To reveal this mystery would require nothing short of the discovery of the principle, and of the essence of life.

Cadaveric Phenomena.—The moment life is extinct, the body assumes the name of *corpse;* from that

moment it presents the following characters—1st. It gradually looses its caloric, and turns cold; this effect is so much the sooner produced, as the temperature of the atmosphere is lower, the disease of longer duration, and emaciation more advanced; 2dly. The body is in a complete state of insensibility; 3dly. It is immobile, and no longer obeys any laws but mechanical impulses and the laws of gravity; 4thly. It presents either a remarkable state of stiffness, or of flaccidity. In the first moments after death, all the parts become remarkably soft, the skin is flabby and pale; but gradually as animal heat subsides, the tissues become more consistent, the muscles undergo a kind of contraction or assumed rigid state, productive of *cadaveric stiffness*, generally considered as the last effort of the contractile power.

It is not uncommon to witness some phenomena of vegetative life persist after death: it is thus *Magendie* has observed, that absorption might still be effected; other physiologists have affirmed that the hair and beard grow. Some are of opinion that digestion may attempt a last effort; it is well known, however, that this function and several others, have been prolonged in the corpse, by the means of galvanism. Some authors think that secretions are continued for a certain time after death. An indisputable fact, however is, that certain excretions take place; thus the rectum, the bladder, and the

uterus, have frequently been seen, to effect after death their usual excretions.

With respect to fluids, they stagnate in their respective vessels. The blood accumulates in the vena-cava, in the right cavities of the heart, and in the vessels of the lungs; the arterics empty themselves, owing to their elasticity, and at the same time animal heat subsides, the capillary vessels contract, the tissues grow paler gradually as the blood returns to the large veins. From that moment, obeying the laws of gravity, this fluid flows to the most depending parts, and the different tissues suffer themselves to be impregnated: hence those livid spots, observable in the different regions of the body, and those red or violet coloured streaks which shew the courses of the veins. Bile also transudes through its reservoir and biliary ducts, and stains the neighbouring parts of a yellow colour. When the corpse is completely cool, the blood coagulates, first in the cavities of the heart, subsequently in the veins, and undergoes in these vessels the same alterations, as if it cooled in the opon air. Finally, a particular motion of decomposition is about to invade the subject, and to restore to the physical and chimical laws a body, which but a few moments back was endowed with life and animation.

Putrefaction.—Putrefaction is a spontaneous decomposition, which invades the corpse when it is to-

tally deprived of life; according to *Thouret*, this is the only decisive character of death. The epoch at which putrefaction occurs, cannot be determined absolutely, since a number of particular circumstances may either retard or forward it considerably: Thus, the nature of the death, the spot where the corpse has been laid, the degrees of temperature and humidity in the atmosphere, &c. However, generally speaking, putrefaction may be said to begin from the fourth to the eighth day; I mean in the open air, it is more slowly effected under ground.

As soon as putrefaction begins, the soft parts gradually become softer, cadaveric stiffness disappears, the humours become remarkably fluid, and transude through all the parts, which they impregnate with their offensive smell. Decomposition generally begins at the abdomen, from whence it extends to all the parts; the epidermis drops off, the flesh soon turns pulpous and green, and separates from the bones, the bones themselves are denuded, and it is only a very considerable time after this, that being deprived of all their organic parts, they crumble into dust. During this decomposition, by the reciprocal action of the elements in fermentation, a great number of new bodies are formed, the principal of which, are: Hydogen, carbon, oxygen, and azote, variously combined, and conjoined with minute quantities of sulphur and phosphorus; and, some solid products, earthy or soapy.

It is thus, all which recalled to mind the material existence of man, vanishes and gives birth to new bodies, the successive changes of which trace an endless circle, which forcibly reminds us of the doctrine metempsychosis, maintained by Pythagoras.

THE END.

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